Defensive Behavior in Principal-Agent Relationships

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Chapter 1

Introduction

In this doctoral thesis, I explore how vague behavioural or legal standards affect agents' decision-making. In particular, I test the extent to which agents engage in defensive behaviour in the face of vague standards. I measure defensive behaviour as the extent to which agents make less than efficient decisions for their principals in order to increase the probability of complying with the vague standard.

In principal-agent relationships, a principal hires an agent to take a decision for him. Common examples include the relationship between firm owner and manager, between physician and patient and between a lawyer and her client. Frequently, these relationships are characterized by information asymmetry: while the principal might have a vague idea of the set of available decisions, only the agent is aware of the full set of options and can rank them according to the principal's expected profit or cost. In reality, even the best decisions can realize negative outcomes. Due to the information asymmetry, the principal or a judge cannot easily distinguish a bad outcome that stems from a sub-standard decision by an unqualified or even negligent agent and a bad outcome of a good decision by the agent. Additionally, agents in these relationships often face dire consequences for sub-standard decision-making. Aside from legal liability, agents are exposed to the principal's scrutiny, a loss in reputation and a reduction in future profits. This constellation of consequences makes established decisions, conservative decisions or default options attractive to the agent, since these choices are more likely to be recognized by the principal (or even by a judge in the course of legal proceedings) as qualified and non-negligent. In this situation, defensive or overcompliant behaviour refers to a choice made by the agent in an attempt to meet a behavioural or legal standard which signals the quality of her decision, and consequently reduces her probability of being held liable for a bad outcome.

The practical relevance of this dissertation is reflected in the effort to restructure liability frameworks in various fields in different countries. In the corporate environment, the Business Judgment Rule[1] was promulgated to enable managers to take innovative decisions without being exposed to a risk of liability. In the health sector, multiple countries have altered liability schemes or introduced state-run no-fault compensation schemes. By reducing the liability pressure and the exposure to vague standards, policy makers seek to encourage the application of novel treatment methods or medication and facilitate socially beneficial deviations from defaults.

This dissertation contributes to two main areas of research: On the one hand, I address the problem of moral hazard for decision-making in principal-agent relationships (e.g. Grossman and Hart, 1983; Harris and Raviv, 1979; Mirrlees, 1976; Shavell, 1997). My specific contribution is that I draw attention to the problem of defensive behavior, as opposed to self-interested behavior in general. On the other hand all three chapters of this dissertation relate to the field of law and economics, specifically to the discussion of optimal legal incentives and standards (e.g. Shavell, 1980; Landes and Posner, 1981; Kahan, 1989; Kaplow, 1992) and the effect of legal indeterminacy (e.g. Craswell and Calfee, 1986; Lang, 2014). Here my contribution consists of providing empirical arguments to a predominantly theoretical discussion.

In Chapter 2, I examine defensive behaviour in the absence of potential monetary liability. I use a laboratory experiment to compare a scenario in which agents have no reason at all to make a defensive decision for their principal to a scenario where the agent may have a non-monetary reason to make a defensive action. I do this in order to establish whether a vague standard of judgement by a principal can, by itself, induce an agent to deviate from the optimal choice. In Chapter 3 and Chapter 4, I test in a laboratory experiment whether increasing the variability of a legal standard increases or reduces socially desirable behaviour. The predictions in both cases are based

[1] The Business Judgment Rule is legal principle derived from Otis & Co. v. Pennsylvania R. Co. (61 F. Supp. 905 (D.C. Pa. 1945)) that grants immunity from liability towards the cooperation for directors, managers, and further agents of a corporation. Immunity was granted as long as agents could prove that they only took decisions within their authority and according to the principle of Good Faith (Arsht, 1979).

on the model of Craswell and Calfee (1986), which is expanded in Chapter 3 to incorporate risk preferences and reference-dependent preferences, and social preferences in Chapter 4.

Chapter 2 was written in cooperation with Prof. Dr. Oliver Kirchkamp[2]. My contribution to this project was the following: idea – major, literature review – major, experimental design and data collection – major, data analysis – minor. Chapter 3 is a joint work with Dr. Sven Hoeppner[3], my contribution here was the following: idea – major, literature review – moderate, theoretical model – minor, experimental design and data collection – major, data analysis – moderate. The last chapter is solely mine. The following is a brief summary of Chapters 2 through 4:

Pride and Malpractice

In Chapter 2, we study the impact of defensive decision-making in principal-agent relationships. In particular, we investigate whether defensive decision-making persists as a signalling mechanism, even in the absence of monetary liability, under anonymity and in a setting without repeated interactions. In a scenario in which agents do not have any financial incentive to make defensive choices, the only reason to do so is to signal their effort and intention towards the principal.

The research is motivated by the results from public health research that show that defensive medicine persists in jurisdictions in which physicians face a relatively low risk of liability (Steurer, Held, Schmidt, Gigerenzer, Tag, and Bachmann, 2009) and even in countries that previously implemented so-called quasi no-fault compensation schemes (Cunningham and Dovey, 2006). Chapter 2 also relates to the economics literature that discuss preferences for social approval (e.g. Akerlof, 1980; Holländer, 1990; Lindbeck, 1997), in principal-agent relationships with moral hazard (Casadesus-Masanell, 2004) and in laboratory experiments (e.g. Rege and Telle, 2004).

In the laboratory experiment we provide a setting in which each participant has the possibility to earn a hypothetical qualification through his work in a real effort task. In the next step, a qualified participant (agent) can then choose between two lotteries for another participant (principal). Depending on which

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lottery the agent chooses, the earned qualification will either be signalled to the principal, or not. We compare this to the results from a similar task in which the agent's qualification is always signalled to the principal, irrespective of the the chosen lottery. The experiment allows to us to determine whether and by how much an agent is willing to reduce his principal's expected profit to signal his earned qualification and to avoid being mistaken for an unqualified agent. Subsequently, we inquire whether this willingness is affected by measures of social preferences.

Our results suggest that some agents are willing to reduce the expected profit of their principals, irrespective of whether qualification is signalled selectively. While we find that the proportion of defensive choices is actually slightly smaller when qualification is signalled selectively, the magnitude of defensive behavior is larger. We do not find this to be associated with measured social preferences. A positive result is the fact that investment in qualification is slightly higher when signals are sent selectively. With the minimal scenario, we try to establish a lower benchmark for the willingness to reduce a principal's expected profit in order to transfer information about acquired qualification and the quality of an activity choice. But as the manipulation is rather weak, we only capture a very weak effect.

To Comply or Not to Comply: The Effect of Changes in Standard Variability on Efforts to Comply

In Chapter 3, we investigate the effect of legal standard vagueness on efforts to comply with the legal standard. In the field of law and economics, our research contributes to the literature by offering an empirical argument to a conflict between legal scholars and economists on the effects of legal uncertainty on rule-subjected individuals: On the one hand, legal scholars claim that difficult-to-predict legal consequences are costly, as they crowd-out socially beneficial activities (Trubek, 1972; Weber, 1978) and advocate the reduction of legal uncertainty (see e.g. D'Amato, 1983; Popelier, 2000; Maxeiner, 2006, 2007; Raitio, 2008; Smits, 2012). This argument is opposed by research from economic theory which finds that increasing legal uncertainty can encourage socially beneficial behaviour, such as the reduction of inefficient overcompliance (Craswell and Calfee, 1986). This also leads to different policy recommendations from both sides: while economists stress the importance of optimal rule design, legal scholars lobby for the reduction of legal uncertainty at all costs.

We base our hypotheses on Craswell and Calfee (1986)'s model that analyses a person's activity choice under a vague legal standard, where own profit and the magnitude of a possible liability payment increase in the activity level. The vague standard is drawn from a known, normal probability distribution. Different degrees of legal standard vagueness are modelled as changes in the dispersion of the probability distribution. As a result of the original model, the authors predict overcompliance at small degrees of legal vagueness and undercompliance at large degrees of standard vagueness. The resulting U-shaped relationship has the feature that at some vague standard, further increases in standard vagueness might actually reduce inefficient overcompliance. The model also offers the intriguing possibility of a second best solution to legal certainty: At least theoretically there exists a level of standard vagueness at which behaviour is efficient. We update the model's assumptions about a person's risk and reference dependent preferences and test the resulting predictions in a controlled laboratory experiment.

Our main results support the standard economic model of Craswell and Calfee (1986): on average we find overcompliance at sufficiently low levels of standard vagueness. This changes beyond a tipping point, any further increases of standard vagueness now reduce the level of overcompliance and eventually induce undercompliance. Moreover, we find two unexpected results that are of interest to the lawmaker. First, the proportion of compliant choices gradually reduces with increasing standard vagueness, while the share of socially desirable (as opposed to socially undesirable) choices sharply drops—with socially undesirable choices far outweighing socially desirable ones, as soon as standard vagueness exceeds the quasi-certain level. Secondly, we find that behaviour becomes more erratic as standards grow exceedingly vague. This loss of the law's coordination function represents a further cost of legal standard vagueness which is not commonly discussed in the literature.

Better Safe than Sorry: Can Social Preferences Mitigate Defensive Behaviour under Vague Standards?

In Chapter 4, I expand the theoretical model and the experimental set-up from Chapter 3, to allow for the presence of social preferences. I thereby test the robustness of ??hapter 3's results and take a closer look at the specific effect of legal standard vagueness in situations with close social proximity between a tortfeasor and an injured party, such as principal-agent relationships. The aim is to determine whether pro-social preferences actually mitigate the occurrence of defensive behaviour.

I generate a set of behavioral predictions based on the inclusion of either inequity aversion, preferences for social efficiency or maximin preferences and proceed to test these in the laboratory. While the payoff structure for the decision maker remains the same as in the earlier experiment, the chosen activity level now generates a real negative externality for another participant, which in turn determines the magnitude of a liability payment. All participants make choices for various levels of standard vagueness, with and without an affected second participant.

As a first result, I replicate the presence of overcompliance, but without the characteristic U-shaped relationship between precaution and the level of standard vagueness in the baseline group. Instead I find that defensive behavior increases with standard vagueness. The collected data therefore casts doubt on the theoretical predictions of Calfee and Craswell (1986) as well as on the experimental results from Chapter 3. Furthermore, I do not find an effect of the introduction of a second participant whose profit is affected by the level of precaution of the decision maker in the treatment group. I find defensive behaviour of the same degree in both groups, which increases with standard vagueness, but that pro-social preferences somewhat mitigate defensive behavior. Yet, the data show that internalized pro-social preferences explain decision making only at low levels of standard vagueness and loose their importance when standards become sufficiently vague. As in Chapter 3, I also find that behaviour becomes increasingly erratic as standard vagueness increases.

Zusammenfassung und Einleitung: Defensives Verhalten in Prinzipal-Agenten-Beziehungen

1.1 Allgemeine Einleitung auf Deutsch

In der vorliegenden Dissertation beschäftige ich mich mit dem Entscheidungsverhalten von Agenten, wenn Rechts- oder Verhaltensstandards nur vage definiert sind. Vor allem interessiert mich hier das Auftreten von defensivem Verhalten, der Bereitschaft des Agenten, suboptimale Entscheidungen für seinen Prinzipal zu treffen, wenn diese Entscheidungen die Wahrscheinlichkeit erhöhen, den vagen Rechts- oder Verhaltensstandard zu erfüllen.

In der Prinzipal-Agenten-Theorie beauftragt ein Prinzipal einen Agenten damit, eine Entscheidung für ihn zu treffen. Charakteristisch für diese Beziehung ist der Wissensvorsprung des Agenten vor dem Prinzipal: Obwohl der Prinzipal eine entfernte Vorstellung von den möglichen Entscheidungsalternativen hat, kennt nur der Agent die Gesamtheit der Optionen und ihren finanziellen Konsequenzen für den Prinzipal. Nur der Agent ist in der Lage, die optimale Option zu identifizieren und auszuwählen. Als Beispiele werden häufig die Beziehung zwischen dem Firmeninhaber und der Unternehmensleitung, zwischen dem Arzt und seinem Patienten oder zwischen dem Anwalt und seinem Klienten benannt.

Man die möglichen Entscheidungsoptionen mit Lotterielosen mit verschiedenen Erfolgschancen vergleichen. Auch eine optimale Option kann für den Prinzipal ein positives oder ein negatives Resultat realisieren; allerdings ist das Ergebnis häufiger positiv als bei suboptimalen Optionen. Auf Grund der vorhandenen Informationsasymmetrie ist es schwierig, für den Prinzipal oder für einen Richter zu entscheiden, ob ein negatives Resultat die Folge einer suboptimalen Entscheidung eines unqualifizierten oder gar varlässigen Agenten war oder einfach das negative Resultat einer optimalen Entscheidung.

Hinzu kommt, dass Agenten in den beschriebenen Beziehungen oft mit unangenehmen Konsequenzen rechnen müssen, wenn man ihnen suboptimale, unqualifizierte oder fahrlässige Entscheidungen nachweisen kann. Neben gesetzlicher Haftung sind Agenten dem Misstrauen und Ärger des Prinzipals ausgesetzt und fürchten den Verlust ihrer Reputation und zukünftiger Aufträge. Diese Konstellation von Umständen macht etablierte und konservative Optionen attraktiver für den Agenten. Da diese Entscheidungsoptionen einen höheren Bekanntheitsgrad haben, ist es wahrscheinlicher, dass der Prinzipal (oder der Richter, wenn es zum Rechtsstreit kommen sollte) diese Optionen als qualifiziert und nicht fahrlässig erkennt. Defensives Verhalten entsteht hier also, weil der Agent dringend den Rechts- oder Verhaltensstandard erfüllen will und darum die Signalwirkung einer Entscheidungsoption über die Erfolgsquote und die Effektivität stellt.

Die praktische Relevanz dieser Dissertation spiegelt sich in der weltweiten Restrukturierung der Haftbarkeit in verschiedenen Bereichen wider. Im geschäftlichen Bereich wurde defensivem Handeln mit der Business Judgment Rule ("Regel für unternehmerische Entscheidungen")[4] vorgebeugt. Dem Unternehmensleiter wird hinsichtlich der zu treffenden unternehmerischen Entscheidungen ein gewisser Spielraum eingeräumt, persönliche Haftbarkeit wird ausgeschlossen so lange der Unternehmensleiter belegen kann, dass er alle Entscheidungen mit Sorgfalt getroffen hat. Im Gesundheitswesen haben einige Länder einen ähnlichen Weg eingeschlagen, indem sie die Haftung für Mediziner eingeschränkt haben oder gänzlich durch staatliche Versicherungen ersetzt haben. Die Verringerung des Drucks durch Haftbarkeit und der Umgang mit vagen Rechtsstandards soll die Anwendung von innovativen Behandlungsmethoden oder Medikamenten fördern und die Abweichung von etablierten Methoden vereinfachen.

Der Beitrag dieser Dissertation verteilt sich auf zwei Hauptbereiche: Auf der einen Seite beschäftige ich mich mit dem Problem von Moral Hazard ("moralischer Versuchung") für Entscheidungen in Prinzipal-Agenten- Beziehungen (z.B. Grossman und Hart, 1983; Harris und Raviv, 1979; Mirrlees, 1976; Shavell, 1997). Statt auf eigennützigem Verhalten im Allgemeinen, liegt mein

[4] Die Business Judgment Rule wird hergeleitet von Otis & Co. v. Pennsylvania R. Co. (61 F. Supp. 905 (D.C. Pa. 1945)).

Fokus auf dem Auftreten von defensivem Verhalten in Folge von Moral Hazard. Auf der anderen Seute befassen sich alle drei Aufsätze mit Themen aus der Rechtsökonomik, der Diskussion zu optimalen Anreizen und Rechtsstandards (z.B. Shavell, 1980; Landes und Posner, 1981; Kahan, 1989; Kaplow, 1992) und dem Effekt von Rechtsunsicherheit (z.B. Craswell und Calfee, 1986; Lang, 2014). Ich trage hier empirische Argumente zu einer weitgehend theoriebasierten Diskussion bei.

In Kapitel 2 widme ich mich defensivem Verhalten in einem System ohne finanzielle Haftung. Mit Hilfe eines Experiments vergleiche ich eine Situation in der Agenten keinen Grund haben, defensive Entscheidungen zu treffen, mit einer Situation, in der sie defensive Entscheidungen treffen können, um ihre Qualifikation zu signalisieren. Das Ziel ist herauszufinden, ob ein vager Verhaltensstandard einen Agenten dazu bringen kann, von der optional Entscheidungsoption abzuweichen.

In Kapitel 3 und Kapitel 4 teste ich mit Hilfe eines Experiments, ob die zunehmende Variabilität eines Rechtsstandards aus gesellschaftlicher Sicht zu mehr oder weniger effizienten Entscheidungen führt. In beiden Fällen basieren die Vorhersagen auf einem Modell von Craswell und Calfee (1986). Das Modell wird in Kapitel 3 um Risikopräferenzen und Präferenzen aus der Erwartungstheorie erweitert. In Kapitel 4 wird das Modell um verschiedenene Sozialpräferenzen ergänzt.

Kapitel 2 ist in Zusammenarbeit mit Prof. Dr. Oliver Kirchkamp[5] entstanden und Kapitel 3 ist ein Gemeinschaftsprojekt mit Dr. Sven Hoeppner[6]. Das letzte Kapitel wurde von mir alleine verfasst.

Defensives Verhalten in Abwesenheit von finanzieller Haftung (Pride and Malpractice)

In Kapitel 2 befassen wir uns mit defensiven Entscheidungen in Prinzipal-Agenten-Beziehungen, wir betrachten Szenarien ohne finanzielle Haftung, unter Anonymität von Prinzipal und Agent, die auch nur einmalig miteinander interagieren. Wenn finanzielle Haftung ausgeschlossen ist, besteht der einzige Grund für defensives Verhalten darin, dem Prinzipal die eigene Qualifikation signalisieren zu wollen.

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Das Projekt wird durch Forschungsergebnisse aus dem Bereich der Gesundheitswissenschaften motiviert, welche zeigen, dass defensive Medizin auch in Rechtssystemen besteht, in welchen das Haftungsrisiko für Mediziner relativ gering ist (Steurer, Held, Schmidt, Gigerenzer, Tag, und Bachmann, 2009), oder wo die Haftung ganz ausgeschlossen ist (Cunningham und Dovey, 2006). Kapitel 2 steht auch im Bezug zur verhaltensökonomischen Literatur, die sich mit der Vorliebe für gesellschaftliche Anerkennung befasst (e.g. Akerlof, 1980; Holländer, 1990; Lindbeck, 1997).

Zu Beginn des Experiments hat jeder Teilnehmer die Möglichkeit, sich durch Leistung in einer Aufgabe eine fiktive Qualifikation zu erarbeiten. Im nächsten Schritt kann ein qualifizierter Teilnehmer (Agent) zwischen verschiedenen Lotterielosen für einen anderen Teilnehmer (Prinzipal) auswählen. Je nachdem welches Los der Agent auswählt, wird die erarbeitete Qualifikation dem Prinzipal signalisiert, oder eben nicht. Wir vergleichen die getroffenen Entscheidungen mit den Ergebnissen aus einer ähnlichen Aufgabe, bei der die erarbeitete Qualifikation dem Prinzipal allerdings in jedem Fall mitgeteilt wird. Der Unterschied zwischen den Aufgaben soll zeigen, ob die Teilnehmer wissentlich suboptimale Entscheidungen für ihren jeweiligen Prinzipal treffen, um dem Prinzipal ihre fiktive Qualifikation zu signalisieren. Anschließend prüfen wir, ob der Grad der Abweichung von der optimalen Entscheidung mit den von uns gemessenen Sozialpräferenzen zusammenhängt.

Wir beobachten, dass ein Teil der Agenten immer suboptimale Entscheidungen trifft, unabhängig davon, ob ihre Qualifikation dem Prinzipal signalisiert wird. Unsere Daten zeigen, dass der Anteil der defensiven Entscheidungen geringer ist, wenn man die Qualifikation gezielt durch defensives Verhalten signalisieren kann. Allerdings ist in diesem Fall die durchschnittliche Abweichung von der optimalen Entscheidung höher in diesem Fall. Durch die Abbildung eines minimalen Szenarios wollen wir eine Untergrenze für das Auftreten von defensivem Verhalten erstellen. "Wie viel defensives Verhalten kann man in der Abwesenheit von finanzieller Haftung, unter Anonymität und bei einmaliger Interaktion erwarten?" Da die resultierende Manipulation nicht sehr stark ist, können wir nur einen schwachen Effekt erfassen.

Verhalten unter vagen Rechtsstandards: Der Effekt von Veränderungen der Variabilität auf das Bemühen den Standard zu erfüllen

In Kapitel 3 befassen wir uns mit dem Einfluss von Rechtsunsicherheit auf das Bestreben einen solchen, vagen Rechtsstandard zu erfüllen. Im Bereich der Rechtsökonomik trägt unsere Forschung empirische Argumente zu dem Konflikt über den Effekt von unsicheren Rechtsstandards, zwischen Rechtswissenschaftlern und Ökonomen bei: Auf der einen Seite behaupten Rechtswissenschaftler, dass enorme Kosten mit der fehlenden Vorhersehbarkeit von rechtlichen Konsequenzen verbunden sind, da diese diverse Aktivitäten mit sozialem Nutzen verdrängen würde (Trubek, 1972; Weber, 1978). Daher bewirbt diese Gruppe die konsequente Reduktion von Rechtsunsicherheit (see e.g. D'Amato, 1983; Popelier, 2000; Maxeiner, 2006, 2007; Raitio, 2008; Smits, 2012). Auf der anderen Seite argumentieren die Ökonomen, dass Rechtsunsicherheit auch den sozialen Nutzen erhöhen kann, zum Beispiel durch die Reduktion von defensivem Verhalten (Craswell und Calfee, 1986).

Die Hypothesen in Kapitel 3 basieren auf dem Modell von Calfee und Craswell (1986). Im Modell wählt eine Person ein Aktivitätslevel. Mit dem Aktivitätslevel steigen gleichzeitig der eigene Gewinn und die Höhe einer möglichen Haftung. Der vage Rechtsstandard wird aus einer bekannten Normalverteilung gezogen. Unterschiedliche Grade an Rechtsunsicherheit werden durch verschiedene Werte in der Varianz der Wahrscheinlichkeitsverteilung modelliert. Das Orginalmodell sagt defensives Verhalten bei geringer Rechtsunsicherheit und fahrlässiges Verhalten bei großer Unsicherheit voraus. Die resultierende U-förmige Beziehung birgt eine Besonderheit, nämlich die Möglichkeit ab einem gewissen Grad an Rechtsunsicherheit durch eine weitere Erhöhung der Unsicherheit, ineffizientes und defensives Verhalten reduzieren zu können. Theoretisch könnte man so auch effizientes Verhalten herbeiführen.

Wir aktualisieren das Modell, indem wir es um Erkenntnisse aus der Verhaltensökonomie erweitern. Die erneuerten Vorhersagen testen wir in einem Experiment.

Unsere wichtigsten Ergebnisse unterstützen das Modell von Calfee und Craswell (1986): im Durchschnitt finden wir defensives Verhalten bei relativ geringer Rechtsunsicherheit. Nach einem Wendepunkt reduzieren weitere Zunahmen an Unsicherheit das defensive Verhalten. Wir finden zwei unerwartete Ergebnisse. Zum einen nimmt der Anteil der rechtskonformen Entscheidungen allmählich mit zunehmender Unsicherheit ab, während der Anteil der effizienten Entscheidungen rapide abfällt. Zum anderen dokumentieren wir, dass das Entscheidungsverhalten mit zunehmender Rechtsunsicherheit erratisch wird. Hier verliert der Rechtsstandard sein Koordinationspotential, was einen weiteren Kostenpunkt der Rechtsunsicherheit verdeutlicht.

Vorsicht ist besser als Nachsicht: Können Sozialpräferenzen defensives Verhalten unter vagen Rechtsstandards abmildern?

In Kapitel 4 erweitere ich das theoretische Modell und das Experimentdesign aus Kapitel 3 um den Einfluss von Sozialpräferenzen. Ich teste damit die Ergebnisse aus Kapitel 3 und fokussiere auf den Effekt von Rechtsunsicherheit in Situationen mit einer gewissen Nähe zwischen einem möglichen Schädiger und einem Geschädigten (wie es der Fall ist, bei Prinzipal-Agenten-Beziehungen). Mein Ziel ist es zu erfahren, ob Sozialpräferenzen das Auftreten von defensivem Verhalten eindämmen können.

Ich generiere meine Vorhersagen unter Einbeziehung von Ungleichheitsaversion, Präferenzen für soziale Effizienz und Maximin-Präferenzen, anschließend teste ich die Vorhersagen mit einem Experiment. Die Struktur des Experiments bleibt im Vergleich zum vergangenen Kapitel weitgehend unverändert, mit dem Unterschied, dass das gewählte Aktivitätslevel nun eine negative Auswirkung auf den Verdienst eines Mitspielers hat. Die Höhe der negativen Auswirkung bestimmt die Höhe der möglichen Haftung.

Das erste Ergebnis ist, dass ich das Auftreten von defensivem Verhalten replizieren kann, allerdings finde ich nicht die charakteristische U-förmige Beziehung zwischen dem Aktivitätslevel und dem Grad an Rechtsunsicherheit. Statt dessen verstärkt zunehmende Rechtsunsicherheit das defensive Verhalten. Die Daten suggerieren, dass es keinen Zusammenhang zwischen der Einführung eines "Geschädigten" und dem gewählten Aktivitätslevel gibt. Die gemessenen Sozialpräferenzen mildern defensives Verhalten zwar ab, erklären Verhaltensunterschiede lediglich für ge- ringe Grade an Unsicherheit. Wie auch in Kapitel 3 finde ich zunehmend erratisches Entscheidungsverhalten, je größer die Unsicherheit ist.

Chapter 2

Pride and Malpractice

Abstract: We present the results of an experiment to study the impact of defensive decision making in principal-agent relationships. We compared scenarios in which agents have or have no reason to make a defensive decision for their principal. We investigate whether agents are willing to reduce a principal's expected payoff in order to transfer information about themselves and the quality of the choice they made for the principal. Accordingly, the manipulation is very weak and we find only a very small effect. Still, we establish that defensive behaviour can occur in the absence of financial liability and that there are other causes which should be considered.

Keywords: signalling; principal-agent; defensive behaviour; no-fault compensation; medical malpractice

2.1 Introduction

Several economic interactions in which two parties cooperate under information asymmetry and who are forced to share risks can be described in terms of principal- agent relationships. The literature is rich in the description of examples of such relationships, such as between employer and employee, professional and client, insurer and insured and between shareholder and management, and in devising strategies to solve the emerging problems (e.g. Grossman and Hart, 1983; Harris and Raviv, 1979; Mirrlees, 1976; Shavell, 1997). All these examples have in common that the principal depends on the outcome of an activity choice which was made by the agent. Slightly different is the model used by Shavell (1979) which assumes that the agent's selected activity doesn't determine the principal's profit alone, but rather does so in combination with a random element.[1]

Since agent and principal often do not derive profits from the possible activity choices in the same way, the agent has an incentive to deviate from the principal's preferred choice to increase his own profit. Such a possibility exists when the principal cannot perfectly observe the agent or has incomplete information about the choice set. This is a common situation, as many agents are hired as expert decision makers by a less informed principal. Incentive schemes, contracts and the possibility to demand restitution in court are considered functional means to discipline selfish agents. However, these measures also produce an unintended consequence: agents might also deviate from the principal's profit-maximizing activity choice, by taking costly actions to signal the quality of their decisions and intentions in order to avoid allegations of being selfish and forgoe potential lititgation.

The potential costs of such 'defensive decisions' in the corporate environment have played a determining role in issuing the Business Judgment Rule[2] and have induced a reconsideration or even replacement of medical malpractice liability frameworks with no-fault schemes in various countries, including New Zealand (1974), Sweden (1975) and Finland (1987).[3]. While a rich body of research in countries with high liability pressure documents that different types of medical treatment are adjusted in response to liability pres-

[1] The model of Shavell (1979) assumes that an agent can select a costly effort level in his work for the principal. The principal's derives utility from wealth, which is a function of the agent's effort and a random factor, the "state of nature". Furthermore, the principal's ability to observe the agent's effort is also contingent on the effort level and the state of nature.

[2] The Business Judgement Rule is legal principle derived from Otis & Co. v. Pennsylvania R. Co. (61 F. Supp. 905 (D.C. Pa. 1945)) that introduces immunity from liability towards the cooperation for directors, managers, and other agents of a corporation, as long as they could prove that all conducted transaction were within their authority and that the decisions were taken according to the principle of Good Faith (Arsht, 1979).

[3] Aside from good medical practise, no-fault compensation schemes are preferred for lower costs as compared to the cost of medical malpractice insurance premiums, lower administrative costs (Danzon, 1994), better and faster compensation for harmed individuals (Brahams, 1988) and better opportunities for error management (Studdert and Brennan, 2001).

sure[4] a questionnaire study on practicioners in Switzerland, where law suits agains physicians are considerably less frequent, by (Steurer, Held, Schmidt, Gigerenzer, Tag, and Bachmann, 2009) shows that even in jurisdictions with relatively low risk of medical liability, physicians order additional screening measures[5] to defend themselves against lawsuits. A study by (Cunningham and Dovey, 2006) revealed that even in countries that adopted quasi no-fault compensation schemes physicians react to official complaints with defensive practices[6]. It can be concluded that the magnitude of defensive behavior is affected by the liklihood and cost of law suits, but that defensive behavior can also emerge when liability pressure is low or even absent. Questionnaire studies with physicians who recently recived a complaint, by Cunningham (2004) attribute this finding to experienced feelings of reduced confidence, anger, guilt and shame associated with a patient's complain. Defensive decision-making, motivated through a preference for social approval and a fear of disapproval is also described in the economic literature. The importance of social approval in motivating economic agents was first mentioned by (Smith, 1759)[7] and can be found in various economic models: e.g as the reason for setting fair, rather than market-clearing wages (Akerlof, 1980) or to explain voluntary cooperative behavior for a pure collective good (Holländer, 1990). The importance of social approval has been related to the principal-agent problem with moral hazard by Casadesus-Masanell (2004) who assumes that agents suffer a disutility, caused by shame or distress if their actions diverge from a given social standard, and adapt their behaviour. Economic experiments have confirmed the motivation

[4] e.g. (Localio, 1993) found that compared to low premium areas, cesarians were three times as common in high premium regions, a later study by (Yang, Mello, Subramanian, and Studdert, 2009) over the period from 1991 to 2003 found a positive relationship between malpractice premiums and primary cesarian sections and a negative relationship between premiums and rates of vaginal birth after cesarean sections. Both studies conclude that the liability environment affects pracitces in obstetrics.]

[5] The study found that 41% of general practitioners and 43% of internists in Switzerland sometimes or often recommended prostate-specific antigen (PSA) screening merely for legal reasons.

[6] A survey and interview study on physicians in New Zealand who recently received a patient complaint by physicians adjusted their behavior subsequently in terms of positive and negative defensive practices. Changes included increased referral rates, documentation and consenting, screening for problem patients and withdrawal from the doctor-patient relationship and specific practice areas.

[7] "We are pleased, not only with praise, but with having done what is praise-worthy. We are pleased to think that we have rendered ourselves the natural object of approbation, (. . .): and we are mortified to reflect that we justly merited the blame of those we live with (. . .)." (Smith, 1759)[p.115, 116]

for social approval in the laboratory in a variety of settings. As one example, Rege and Telle (2004) find that contributions to a public good double when other participants can observe contributions, as compared to the anonymous setting.

The finding that defensive behaviour cannot easily be eroded by the adjustment of financial liability motivates our research. We try to establish a lower benchmark for the willingness to reduce a principal's expected profit in order to transfer information about acquired qualification and the quality of an activity choice. In a laboratory experiment, agents can choose between two different lotteries, a default lottery and an alternative lottery. The two lotteries differ in their respective probabilities for a good and a bad outcome for a principal. In the case of the physician, the two lotteries resemble two types of medical treatment. Furthermore, the choice of the lottery also determines how the information about the quality of the agent's choice is signalled to the principal. With the default lottery the quality is signalled to the principal with certainty. The default lottery can be thought of as a frequently used medication or an additional screening measure in the medical context. The alternative lottery only signals quality some of the time, namely when the outcome for the principal is good. When the outcome is bad, the principal cannot distinguish between the 'unfortunate' outcome of a qualified choice, or the typically bad outcome produced by an unqualified choice. All other things equal, agents prefer to choose the lottery which always signals the quality of the choice. This is certainly the case when signalling choice quality can prevent financial liability in case of a bad outcome for the principal, but should also hold in the minimal scenario to prevent the previously mentioned emotional consequences.

Therefore the agent's choice is driven by a trade-off between maximizing the principal's expected profit on the one hand and by a desire to make a choice which signals quality. As s consequence of this dilemma, we expect that agents are willing to choose a default option for their principal, even when the expected payoff is significantly lower than that of the non-standard alternative. This behaviour is congruent with the definition of moral hazard.

In this following Section 2.2 we will give a detailed description of the depicted situation, the experimental set-up, the relevant hypotheses and the conduction of the experiment. The hypotheses will be tested in Section 4.4. We will then evaluate the results and their implications in Section 2.4 and finally present our concluding remarks in Section 2.5.

2.2 The Experiment

2.2.1 The Situation: Signalling in Principal-Agent Relationships

In this study we investigate whether an agent is willing to reduce her principal's expected profit in order to to signal the quality of her choice for the principal, to her principal. We want to determine whether defensive behaviour can prevail in the absence of legal liability or monetary compensation, simply because of a desire by agents to signal their ability and intention to make qualified choices, in order to gain social approval and avoid disapproval.

We depict a principal-agent relationship, such as can be found between a firm owner and firm manager or between a physician and her patient. In this relationship, the principal needs to choose one option among multiple possibilities. As the principal lacks information, he can neither see the full range of choices nor determine the possible outcomes of each choice. Accordingly, the principal delegates the choice to an agent whose task it is to make the best possible choice for her principal. In the business context, such choices concern the adoption of a specific business strategy or selecting an investment opportunity among several possibilities. In the physician-patient context, physicians choose for their patients among a variety of diagnostic tools and treatment possibilities and between various types of medications.

In both real world scenarios, the agent's choice options can be described as lotteries. Each choice option can have more than one outcome and each outcome is realized with a specific probability. If we simplify the space of possible outcomes, we can say that each choice option can either lead to a good outcome (success) or to a bad outcome (failure). An investment in a new product line can either be successful and realize a profit, or it can be a failure and incur a loss. Similarly, a physician can prescribe a type of medication which either cures the patient or fails to do so.

In the examples given, the agent's ability to select the profit-maximizing option for the principal depends on his qualification. An agent who has invested time and effort into her qualification at some earlier point in time is able to identify the success probabilities of the available choice options. Therefore, she can pick the choice-lottery that maximizes the principal's expected profit. Instead, an 'unqualified' agent will not be able to distinguish lotteries based on their outcomes and will therefore not be able to make a qualified choice. For simplicity we assume that the unqualified agent realizes a bad outcome for her principal every time she makes a choice. It follows that principals dislike cooperating with unqualified agents, and that agents who have invested time and effort into their qualification prefer not to be mistaken for unqualified agents.

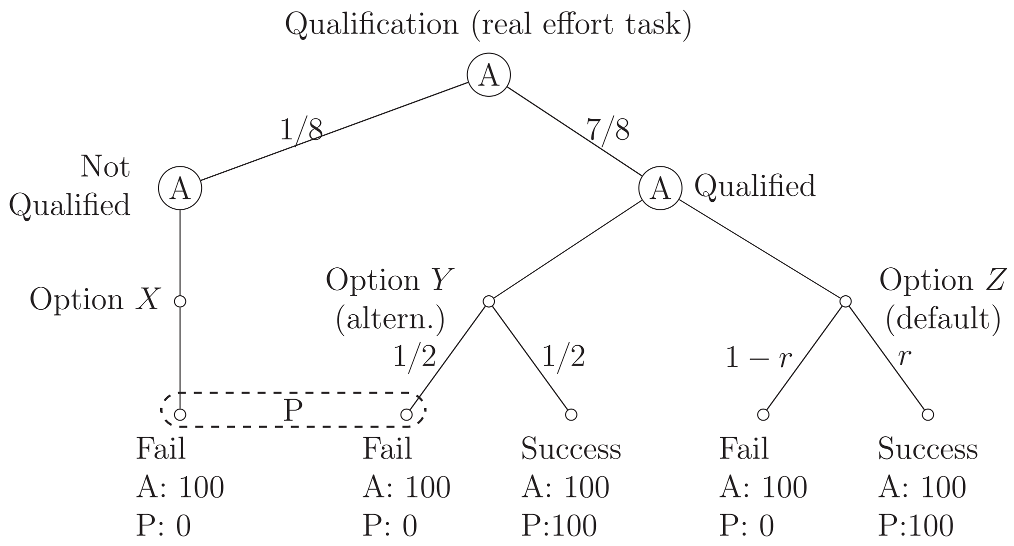
A further characteristic of this type of interaction is the availability of conservative or 'defensive' choices, which resemble a default option. In the corporate setting, this means choosing a strategy which is already in place or investing in a new project which is in line with the company's existing business plan. In the medical setting, a physician might order an additional commonly used diagnostic test or choose a frequently prescribed type of medication over a promising, innovative one. While these choices are not profit-maximizing all the time, they are not contested as being choices that a qualified agent would make.

In the aftermath of an agent's choice, the principal usually only receives two types of information. First, he observes the choice outcome that is realized for him (success or failure). In the simplest case, the principal can infer that the agent was qualified if the outcome is a success and he incurs a positive payoff of some kind. But even if the realized outcome from the choice lottery is bad, the principal can still recognize a qualified agent as long as a default choice option was selected. While the principal does not know whether the default option was the best choice available, he knows that only a qualified agent could have chosen this option.

Hence, if the outcome from the choice option is bad and the agent didn't choose a default, it is impossible for the principal to distinguish whether the agent was qualified and chose a non-default (alternative) option or whether the agent was not qualified at all. In reality, the determination of an agent's qualification is not only relevant to the principal, but also to legal authorities. In case of conflict between principal and agent, legal authorities aim to assign liability exclusively to agents who caused a negative outcome through a lack of research, precaution or care.

The agent's choice is therefore characterized by a trade-off between maximizing the principal's expected payoff on the one hand and by a desire to signal his own quality. One way to signal quality is for the agent to choose the default option, even if it is not the choice that maximizes the principal's expected payoff. We abstract from various relevant factors, such as the mag-

Figure 2.1 Game representation of the agent



nitude of financial liability, personal interaction, incentive wage contracts and the possibility to build a reputation. Instead, we want to determine whether defensive decision making can be motivated in a minimal signalling scenario.

2.2.2 Experimental Set-up

Before the first stage of the experiment, all participants are randomly divided into agents and principals and each agent is assigned to a principal. Each agent's choice in the main game has financial consequences for his or her assigned principal. In order to increase the quantity of observations, all participants make choices from the agent's perspective and only learn about their actual role at the end of the experiment. The experimental set-up is depicted in Figure 2.1.

In the first stage of the experiment, all participants perform a real effort task. The participants count the number of ones in a series of five-by-five matrices, the aim is to report correct results for as many matrices as possible. The individual performance in the task determines whether the agent is awarded a qualification. Specifically, the seven participants in a group of eight, who solve the highest number of matrices become qualified. In each group one participant out of eight remaines unqualified. The participants are instructed about the qualification procedure and about the consequences that obtaining a qualification has for the range of possible outcomes they can realize for their principals.

In the second stage of the experiment the seven qualified agents in each group are asked to choose among two different lotteries (Option Y and Option Z). Option Y and Option Z differ in terms of the information the principal receives. Option Z represents the default or the conservative choice option. Irrespective of Option Z's outcome, the principal receives the information that the agent performed well in the real effort task and subsequently selected Option Z for the principal.

If Option Y is chosen, the principal only receives information if Option Y is successful. In that case the principal learns that the agent earned a qualification and chose Option Y for his principal. If Option Y is not successful, the principal is informed that he will not receive a payoff.

Unqualified agents don't make any choice – Option X is always implemented for the principals of unqualified agents. Principals with Option X receive the same message as in the case of a failed Option Y: namely that they will not receive a payoff.

Qualified agents make their choice between Option Y and Option Z by means of the Becker-DeGroot-Marschak (BDM) mechanism (Becker, DeGroot, and Marschak, 1964). Instead of selecting directly between Option Y and Option Z, the agents are asked to state the lowest success probability, r, at which they still prefer implementing the default, Option Z, over implementing the alternative Option Y, which always has a success probability of $1/2$. After selecting r, a random number between zero and one, b, is drawn within the BDM mechanism. If the random number, b, is smaller than the agent's stated minimum probability r, the alternative Option Y is implemented. If b is larger than r, Option Z is implemented for the agent and his principal. The success probability of Option Z in this case is equal to b. The stronger an agent's preference for the default choice option, the smaller should be the selected value of r.

This decision mechanism was implemented to elicit the agent's 'willingness to pay' for the signaling of qualification that is associated with a failed Option

Z, and that is not available with a failed Option Y. The unit of payment in this case is the deviation from the optimal decision for the principal. The selected value of r in the BDM mechanism provides an incentive-compatible measure for defensive decision making.

In the third stage of the experiment the selected lotteries were realized and the participants were informed about their role (agent or principal) and their payoff. Principal's also received information about their agent's qualification in case Option Z was realized.

We compare the results from this treatment to a baseline group, in which there is no difference between Option Y and Option Z with respect to the information that is signalled to the principal. As Option Y and Option Z are similar, agents should not select values of r below 1/2. The baseline comparison is necessary to verify that any reductions in r below 1/2, actually stemm from the difference in information between Option Y and Option Z and that other causes can be ruled out.

2.2.3 Hypotheses

Participants in the role of the agent who care for the well-being of the principal, but who are not interested in the beliefs of the principal regarding their qualification, are indifferent between Option Z and Option Y (i.e. the default treatment and the alternative treatment). Accordingly, in the BDM mechanism, they should bid a success probability $p = 1/2$. Agents in the treatment condition who care about their principal's belief might trade off the well- being of the principal against a favourable signal and the associated belief. They would be willing to accept a lower value of r in order to increase the probability of a favourable belief about their own qualification. We have the following hypotheses:

> **Hypothesis 1:** More participants will choose $p = 1/2$ in the baseline condition than in the treatment condition.

> **Hypothesis 2:** Of those participants who do not choose (almost) $p = 1/2$, the chosen values for r should be higher in the baseline condition.

Furthermore, the social values of a participant might have an effect on the chosen value of r:

Hypothesis 3: We expect a positive effect of pro-social or altruistic attitude on the chosen level of r.

2.2.4 Conducting the Experiment

The experiment was conducted at the research laboratory of the Friedrich-Schiller University in Jena, in cooperation with the Max-Planck Institute for Economics. All 128 participants were recruited on-line via ORSEE (Greiner, 2015) and were students at the University of Jena. A total of 8 sessions took place in June, July and December 2014. In each session half of the participants were allocated to the baseline group and the other half to the treatment group. The experiment was computerized using z-Tree (Fischbacher, 2007), in particular we constructed a graphical interface to better instruct the participants about their range of possible inputs and the consequences. A sample screenshot of the experiment can be found in Figure 2.3 in the Appendix. To ensure that all participants could understand and apply the BDM mechanism, we instructed the participants with the help of narrated video presentations[8]. Each session consisted of six repetitions of the main game, participants were re-matched in each round according to stranger-matching protocol. After six rounds of the main game, the participants' risk preferences according to Holt and Laury (2002) were elicited and the social value orientation according to the slider measure by Murphy, Ackermann, and Handgraaf (2011) was recorded. At the end of the experiment, one of these 6 rounds was randomly selected for payment. Throughout the experiment, the participants could not communicate with each other and principals and agents remained completely anonymous.

All subjects received a show-up fee of 2,50 € as they entered the laboratory. In addition to the show-up fee agents received a flat payment of 100ECU $\hat{=}$ 10 € at the end of the experiment. By design, this payment was independent of the obtained qualification, the selected choice option or the resulting payoff for the principal. In case a choice option was successful, the principal also received a payoff of 100ECU $\hat{=}$ 10 € at the end of the experiment. If the

[8] https://www.dropbox.com/sh/x4bd1inx9ait4y2/AACIVHD269sKSrmI1zsy9ovUa?dl=0

selected option was not successful, the principal received no further payoff after the experiment.

2.3 Results

We present the results in two subsections. In the first subsection, we provide descriptive statistics, give a brief overview of self-reported behaviour from the questionnaire and introduce personal characteristics with regard to social and risk preferences. In the second subsection, we conduct a detailed evaluation of the data to draw inference for testing the experimental hypotheses set out in the previous section.

2.3.1 Descriptive statistics and self-reported behaviour

The sample comprises data from eight sessions with a total of 128 students from several different academic backgrounds. In each session, six rounds of the main game were played, followed by two post tests and a questionnaire. Each session lasted approximately 55 minutes and subjects earned on average 7.40 € + 2.50 € (show-up fee). Approximately 48% of the participants were female and the average age of the participants age was approximately 24 years.

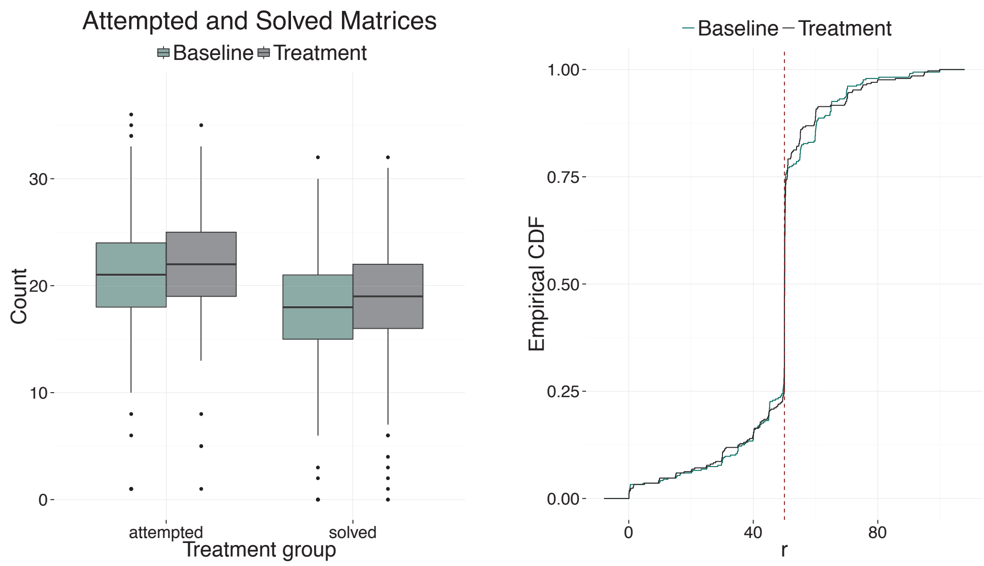
In the qualification task, participants attempted to solve on average a higher number of matrices in the treatment group (22 matrices), as compared to the baseline group (21 matrices). Of those attempted, an average of 19 matrices were solved correctly in the treatment group and 18 matrices were solved correctly in the baseline group. The difference in performance is depicted in the left panel of Figure 2.2.[9]

The right panel of Figure 2.2 depicts an ecdf-plot of the participant's minimum required success probability for preferring Option Z over Option Y in the baseline and in the treatment group. The observed level of the variable ranged from 0% to 100%, with a slightly lower average in the treatment group (48.5%) as compared to the baseline group (48.8%). While the graph clearly indicates

[9]The graph does not depict two extreme outliers (59, 73) in the group of attempted matrices. In both cases participants did not actually count the number of ones, but repeatedly entered one answer, as quickly as possible.

that participants in treatment and baseline group are mostly indifferent between the two options and largely make optimal choices for their principals, we still observe a considerable number of deviations from the optimal choice to both sides of the distribution. A total of 31.8% of all decisions in the treatment group and 34.9% of the decisions in the baseline group deviate by more than 10% from the optimal choice. Contrary to our theory, defensive behaviour also seems to be more prevalent in the baseline group than in the treatment group. A further feature of the depicted minimum success probabilities (r) in Figure 2.2 is that they diverge from the optimal point ($1/2$) in both directions. This is striking as there seems to be no obvious advantage for the agent, from increasing r beyond $1/2$. Under the assumption that participants have understood the game and are not spiteful towards their principal, the only other explanation is that this divergence serves as a signalling mechanism as well. As all participants have full information about the possible strategies in the game, they also know about the possibility to reduce the principal's success probability in order to implement the signal-generating Option Z. As a consequence, they might actually want to avoid Option Z, as it could be understood as a signal for defensive behaviour. Therefore, for the remainder of the paper we will treat divergences in both directions as instances of defensive behaviour.

Figure 2.2 Performance in the RET and choices in the main task, by treatment



To gain an impression of the participants' understanding of the BDM mechanism from the video instructions, all participants were asked to report their subjective level of understanding on a scale from 0 to 100. On average, the participants reported to have had a good understanding (84/100) of the main task. In addition, participants were also asked to report on their behaviour during the main game in a questionnaire. The explicit wording of the questions, as well as the results can be found in Table 2.6 in the Appendix. On average the participants reported that performing well in the initial task was very important to them (81/100) and that they felt a considerable degree of responsibility towards their principal (71/100). While participants reported to be only mildly interested in signalling their qualification (33/100), 69% reported discomfort in case their principal would not receive a further payoff at the end of the experiment. Anonymity towards the principal mattered for slightly less than half the participants (38%) and choices may have been somewhat different if the agents faced meeting their principals at the end of the experiment (36/100).

As the main task focuses on making risky, payoff-relevant choices for another person, we have also recorded risk preferences according to Holt and Laury (2002) and social preferences and elicited social preferences according to the ring measure as devised by Murphy, Ackermann, and Handgraaf (2011) and implemented for z-Tree by Crosetto, Weisel, and Winter (2012). We find representative values for both measures: the majority of the participants exhibit slight risk aversion, 79 participants exhibit individualistic preferences, 48 have pro-social preferences and one participant has competitive preferences. Both measures are depicted in Figure 2.4 in the Appendix.

2.3.2 Detailed Analysis

Performance in the real effort task As discussed earlier, the left panel of Figure 2.2 shows that subjects in the baseline group solve slightly fewer matrices in the real effort task than participants in the treatment group. The difference is, however, not large. To more formally assess the difference between treatment and baseline we assume that each participant solves problems at an approximately constant rate. In this case the total number of problems solved follows a Poisson process. Hence, we estimate the following Poisson regression

Table 2.1: Estimation of Equations (2.1)–(2.4) for attempted problems.

	Mean	2.5%	97.5%	psrf	sseff
$\lambda_{\text{Base.}}$	3.00	2.89	3.11	1.0043	622
$\lambda_{\text{Treat.}}$	3.10	2.99	3.21	1.0032	559
$\lambda_{\text{Treat.}} - \lambda_{\text{Base.}}$	0.10	-0.06	0.26	1.0021	604
τ_1	23.25	16.13	32.38	1.0002	9026
τ_2	88.25	18.09	263.89	1.0012	1969

Table 2.2: Estimation of Equations (2.1)–(2.4) for correctly solved problems.

	Mean	2.5%	97.5%	psrf	sseff
$\lambda_{\text{Base.}}$	2.84	2.69	2.97	1.0921	420
$\lambda_{\text{Treat.}}$	2.92	2.80	3.05	1.0125	510
$\lambda_{\text{Treat.}} - \lambda_{\text{Base.}}$	0.09	-0.09	0.28	1.0409	516
τ_1	11.82	8.30	16.22	1.0014	7680
τ_2	80.74	10.84	280.33	1.0148	1708

with random effects for each individual and for each matching group:

$$Y \sim P(\exp(\lambda_T + \nu_{1,s} + \nu_{2,g})) \tag{2.1}$$

$$\lambda_T \sim N(0, .0001) \tag{2.2}$$

$$\text{for } k \in \{1,2\} : \nu_{k,\cdot} \sim N(0, \tau_k) \tag{2.3}$$

$$\tau_k \sim \Gamma(m_k^2/d_k^2, m_k/d_k^2), \quad m_k \sim \Gamma(1,1), \quad d_k \sim \Gamma(1,1) \tag{2.4}$$

P, N, and Γ are the Poisson, Normal, and Gamma distribution, respectively. Y is the number of problems, λ_T is the arrival parameter for treatment T (baseline or treatment), $\nu_{1,s}$ is a random effect for participant s, $\nu_{2,g}$ is a random effect for the matching group g.

Estimation results, based on vague priors, are shown in Table 2.1 and in Table 2.2 for the number of attempted problems and for the number of correctly solved problems, respectively. In both cases the number of problems is slightly larger in the treatment condition, but the 95%-credible interval includes positive as well as negative values.

Result 1 (Qualification): Participants in the treatment condition invest slightly more in obtaining a qualification, as compared to the baseline.

Willingness to accept risk The right panel of Figure 2.4 in the Appendix displays the chosen success probabilities r for the baseline and treatment group. Indeed, a large group of players bid a success probability r close to 1/2. To formally assess the difference between the baseline group and the treatment group, we use a mixture model where r is drawn from a Normal distribution with small variance (large precision) or from a Normal distribution with a larger variance (small precision).

$$r_{s,t} \sim N(\mu_{T,k_s} + \nu_{1,s} + \nu_{2,g} + X, \tau_{k_s}) \tag{2.5}$$

$$k_s \sim \text{dbern}(p_T), \quad p_T \sim \text{Beta}(1,1) \tag{2.6}$$

$$\text{for } k \in \{1,2\} : \mu_{T,k} \sim N(50, .001) \text{ with } \mu_{\text{Treat.},2} = \mu_{\text{Base.},2} \tag{2.7}$$

$$\text{for } k \in \{1\dots 4\} : \tau_k \sim \Gamma(m_k^2/d_k^2, m_k/d_k^2),\ m_k \sim \Gamma(1,1),\ d_k \sim \Gamma(1,1),\ \tau_1 < \tau_2 \tag{2.8}$$

$$\nu_{1,s} \sim N(0, \tau_3 \cdot \tau_1/\tau_k) \quad \text{and } \nu_{2,g} \sim N(0, \tau_4 \cdot I(k=1)) \tag{2.9}$$

Here $r_{s,t}$ is the minimum acceptable success probability for subject s in period t of the experiment, k_s is the classification of the subject into distribution 1 (wide) or 2 (narrow), and $\mu_{T,k}$ and τ_k determine the shape of the two distributions for treatment $T \in \{\text{Base.}, \text{Treat.}\}$ and classification k. As before we include random effects $\nu_{1,s}$ for the subject s and $\nu_{2,g}$ for the matching group g. Below we will also include controls X, but for the time being we have $X = 0$. We scale the precision of the random effect for subjects depending on the classification proportional to the precision of $\mu_{T,k}$. For simplicity we only include a random effect for groups for participants from the wide classification.

Estimation results are shown in Table 2.3. The model, indeed, classifies participants quite clearly. There is one narrow distribution with mean 50.1 with a precision of 48.8 and a wide distribution with means 48.5 or 46.8 depending on the treatment. The precision of the latter distributions is considerably smaller, only 0.00606.

Our estimation classifies participants into those choosing values of r very close to 1/2 and those deviating from 1/2. This classification is actually very

Table 2.3: Estimation of Equations (2.5–2.9)

	Mean	2.5%	97.5%	psrf	sseff
$p_{\text{Base.}}$	0.42	0.30	0.54	1.0000	40314
$p_{\text{Treat.}}$	0.49	0.37	0.61	1.0000	39313
$p_{\text{Base.}} - p_{\text{Treat.}}$	-0.07	-0.24	0.10	1.0000	40070
$\mu_{\text{Base.},1}$	48.46	41.50	55.18	1.0011	1562
$\mu_{\text{Treat.},1}$	46.81	39.71	53.76	1.0012	1587
$\mu_{\text{Base.},2} = \mu_{\text{Treat.},2}$	50.10	50.04	50.16	1.0015	1698
$\mu_{\text{Base.},1} - \mu_{\text{Treat.},1}$	-1.66	-11.48	8.38	1.0015	1539
τ_1	0.01	0.01	0.01	1.0004	15790
τ_2	49.02	40.84	58.96	1.0015	4156
τ_S	24.19	17.36	32.45	1.0001	13451
τ_G	1.35	0.02	5.12	1.0145	1269

clear. 1 percent of the subjects are perfectly classified, i.e. in 40000 different samples the same participant always goes into the same category.

Let us first look at Hypothesis 1. For the baseline group, a relative fraction of 0.42 of players is classified as from the narrow distribution (close to $r = 1/2$). In contrast to Hypothesis 1, the fraction of 0.492 for the treatment group is actually larger than for the baseline group.

> **Result 2 (Hypothesis 1):** We find that the propotion of participants who choose $r = 1/2$ is slightly larger in the treatment group, compared with the baseline.

Let us next look at Hypothesis 2. We expected that $\mu_{\text{Treat.},1} > \mu_{\text{Base.},1}$. This is confirmed by the estimation. The difference is, however, not large. The 95% credible interval for $\mu_{\text{Base.},1} - \mu_{\text{Treat.},1}$ includes positive and negative values.

> **Result 3 (Hypothesis 2):** We find that the average level of r is slightly higher in the baseline group, compared with the treatment.

Controlling for performance Let us next investigate the impact of heterogeneity in performance in the real-effort task. The direction of the expected

Table 2.4: Estimation of Equations (2.5)–(2.9) including performance in the real effort task

	Mean	2.5%	97.5%	psrf	sseff
$p_{\text{Base.}}$	0.42	0.30	0.54	1.0001	40281
$p_{\text{Treat.}}$	0.49	0.37	0.61	1.0000	38694
$p_{\text{Base.}} - p_{\text{Treat.}}$	-0.07	-0.24	0.10	1.0000	39706
$\mu_{\text{Base.},1}$	48.07	41.54	54.59	1.0016	1702
$\mu_{\text{Treat.},1}$	46.56	39.62	53.55	1.0018	1644
$\mu_{\text{Base.},2} = \mu_{\text{Treat.},2}$	50.09	50.04	50.15	1.0021	1787
$\mu_{\text{Base.},1} - \mu_{\text{Treat.},1}$	-1.52	-11.26	8.11	1.0014	1638
$\beta_{\text{perf.Base.}}$	-0.15	-0.97	0.68	1.0002	6065
$\beta_{\text{perf.Treat.}}$	-0.41	-1.27	0.45	1.0003	9202
τ_1	0.01	0.01	0.01	1.0001	15886
τ_2	48.74	40.73	58.16	1.0024	6694
τ_S	24.79	17.73	33.28	1.0001	14296
τ_G	1.39	0.03	5.36	1.0056	1602

effect is not quite clear. It is possible that subjects who have worked harder and have solved more problems in the real effort task have a bigger incentive to behave in a defensive manner, as their qualification was more costly than that of the below-average achievers.

Alternatively, performance in the real effort task might simply be an instrument with which the true intention of the individual can be determined. Those who solved the most tasks genuinely cared about the outcome for their principal, and accordingly also avoided defensive choices in the next stage of the game. Those who mainly cared about the signal they sent only had an incentive to work slightly more than the lowest performer in the group, and subsequently engaged in defensive behaviour, to signal their quality.

To study this question more formally, we set the control variable from Equation (2.5) to $X = \beta_{T,k} \cdot P$ where P is the performance.

Estimation results are shown in Table 2.4. We find that performance in the real effort task has a small negative effect on the chosen success probability r. For both the treatment group and the baseline group, the 95% credible interval contains positive and negative values. Also, the difference between the effects can be positive as well as negative. We also see that estimates for p and μ do

Table 2.5: Estimation of Equations (2.5)–(2.9) including social value orientation and risk

	Mean	2.5%	97.5%	psrf	sseff
$p_{\text{Base.}}$	0.42	0.30	0.54	1.0000	40000
$p_{\text{Treat.}}$	0.49	0.37	0.61	1.0000	36837
$p_{\text{Base.}} - p_{\text{Treat.}}$	-0.07	-0.24	0.10	1.0000	38949
$\mu_{\text{Base.},1}$	47.88	41.07	54.62	1.0033	1562
$\mu_{\text{Treat.},1}$	46.85	39.91	53.97	1.0017	1580
$\mu_{\text{Base.},2} = \mu_{\text{Treat.},2}$	50.10	50.04	50.16	1.0022	1626
$\mu_{\text{Base.},1} - \mu_{\text{Treat.},1}$	-1.03	-10.77	8.57	1.0034	1573
β_{risk}	0.24	-0.14	0.63	1.0038	1735
β_{svo}	0.76	-1.45	2.98	1.0010	1920
τ_1	0.01	0.01	0.01	1.0001	16464
τ_2	48.56	40.64	57.94	1.0003	6643
τ_S	23.66	16.77	31.84	1.0001	11222
τ_G	1.31	0.02	5.41	1.0052	1290

not change much as compared to Table 2.3.

Controlling for risk and social value orientation Let us next check the impact of risk aversion and social value orientation. To do this, we use as a control in Equation (2.5) $X = \beta_{\text{svo}} + \text{svo} + \beta_{\text{risk}} + \text{risk}$, where svo is the critical value from the Holt and Laury (2002) task and risk the social value orientation.

Table 2.5 shows the estimation results. We see that the credible interval for risk aversion and social values includes both positive and negative values. We also see that estimates for p and μ do not change much as compared to Table 2.3 and 2.4. Therefore we cannot confirm Hypothesis 3.

> **Result 4 (Hypothesis 3):** Social value orientation does not seem to affect the selected level of r.

2.4 Discussion

We have presented the results of an experiment we conducted to investigate whether defensive behaviour in principal-agent relationships can be eroded by merely removing financial liability, or whether it persists as a means of signalling qualification. We compared two scenarios, one (our baseline) where participants in the experiment have no reason to make a defensive investment, and another (our treatment) where those participants who care about the beliefs of the player to whom they are matched in the experiment would make a defensive investment.

We use the strategy vector method to elicit choices in the experiment. There are two ways how an effect could be measured in the experiment: as the fraction of players who choose a strategy r close to $1/2$ in our experiment and by the amount of deviation from $r = 1/2$. In both dimensions we did not find a substantial effect in our experiment. This result does not change when we control for performance in the real effort task, for risk aversion or for social values. Therefore, we were unable to establish a lower benchmark for the emergence of defensive behaviour.

If we apply this specific result to the practical domain, it means that we should not expect agents to engage in defensive behaviour to signal information about their qualification. While this result sounds like good news to all those who work on curtailing defensive behaviour, we need to keep in mind that we have studied a scenario where the incentive for a defensive investment was extremely weak. In this minimal scenario, the only reason to make such an investment is to control the beliefs of an anonymously matched other player. We purposely abstracted away from all other reasons for defensive investments, such as a repeated interaction with the principal, the fear of litigation or the variation in social distance to the affected principal.

In particular, establishing anonymity between the principals and the agents distinguishes the experimental results from the real world examples we referred to earlier: business managers, lawyers and especially physicians, who all have closer relationships with their respective principals. The reduced social distance is believed to increase incentives for taking or at least signalling beneficial decisions for the principal. Experimental evidence by Bohnet and Frey (1999) shows that dictators make significantly more generous offers to the recipient if the latter can be identified by the dictator. Furthermore, the authors find that the proportion of dictators who chose an equal division increased much further when the recipient could also identify the dictator. (Charness and Gneezy, 2008) confirm that dictators make more generous offers when they can identify the recipient, but also show that this type of increased charity is crowded out by strategic considerations in the ultimatum game.

The experimental evidence suggests that eliminating anonymity in the experiment would generate a more salient incentive for using defensive decision making as a signalling mechanism in the treatment group. By removing social distance, participants in the treatment group would experience more negative feelings when they are mistaken for unqualified agents and would choose to deviate from the optimal choice more frequently and to a larger extent. The results from the questionnaire confirm this intuition. Participants felt a considerable level of responsibility for their principal and reported discomfort in case the principal left the experiment without receiving a pay-off. A considerable proportion of the participants also indicated that the provided anonymity in the experiment affected their decision and that their choice would be different in a scenario in which they would meet their assigned principal at the end of the experiment. Similarly, the pressure from building a reputation for repeated interactions or from signalling in a selection process are also expected to fortify the treatment effect. A replication of the experiment under two-way identification is therefore expected to increase external validity, as well as the strength of the observed effect and is suggested for further research.

2.5 Conclusion

In this experimental study, we have investigated whether defensive behaviour in principal-agent relationships can be eroded by removing financial liability or whether it persists as a means of signalling qualification. In order to establish a lower benchmark for the willingness to engage in defensive behaviour, we compared two scenarios in which agents have or don't have an incentive to make defensive investments in order to signal information about their qualification to their allocated principals.

We cannot confirm that agents in the incentive-free group choose the optimal decision for the principal more often. While the diversion from the optimum is slightly smaller in the incentive-free group, this difference is not significant. Finally, we do not find these results to change when we control for performance in the real effort task, for risk aversion or for social values.

2.6 Appendix

Table 2.6: Results from the questionnaire

Self-reported understanding (0 – 100) "Do you feel that you understood the instructions and the experiment?"	Observed range	Mean
	0 – 100	84
Importance of qualification (0 – 100) "How important was it for you to solve the initial task successfully?"	0 – 100	81
Importance of signalling (0 – 100) "How important was it to you that the second player would receive information about your performance in the real effort task?"	0 – 100	33
Discomfort with bad outcome Yes/ No	Observed answers	Percentage "Yes"
"Would you feel uncomfortable if you didn't realize an additional payout for your second player?"	Yes/NO	69%
Anonymity Yes/ No "Was your decision affected by the condition of anonymity towards the other player?"	Yes/NO	38%
No Anonymity (0 – 100)	Observed range	Mean
"How much more important would it have been for you to signal your performance in the initial task, if the other player was personally introduced to you at the end?"	0 – 100	36

Figure 2.3 Sample Screen of the Decision Screen in the Experiment

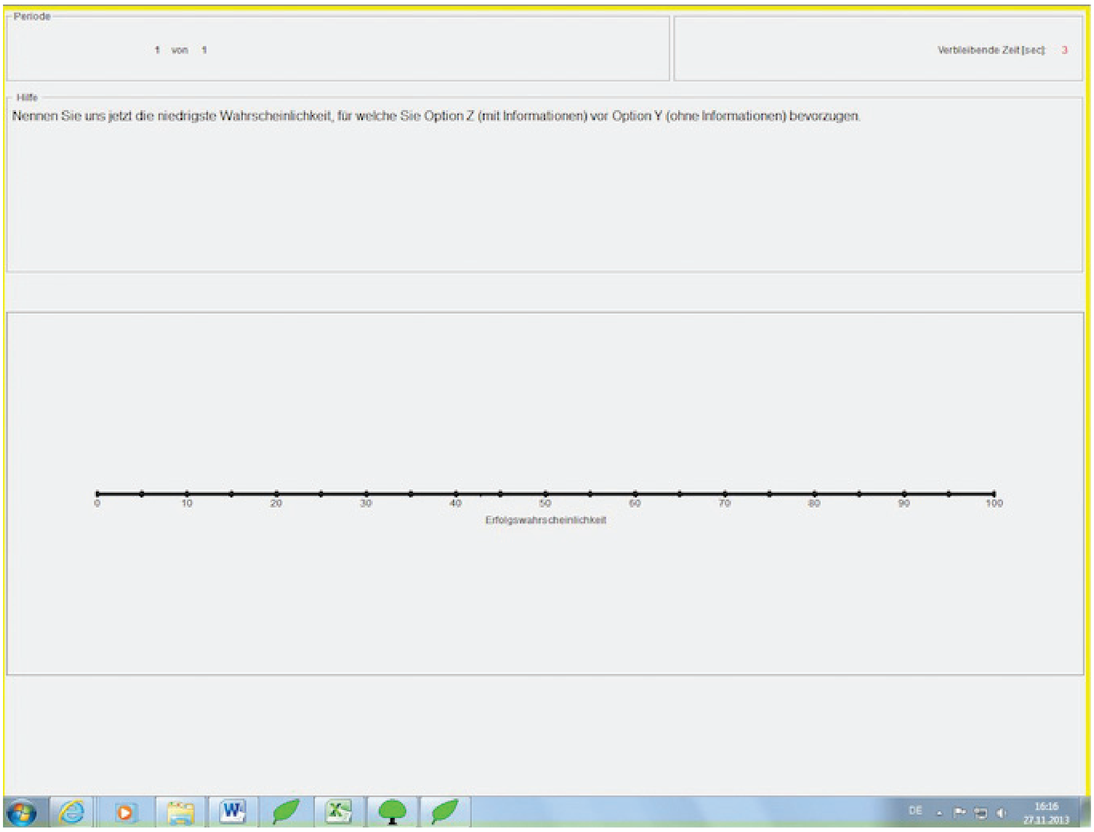
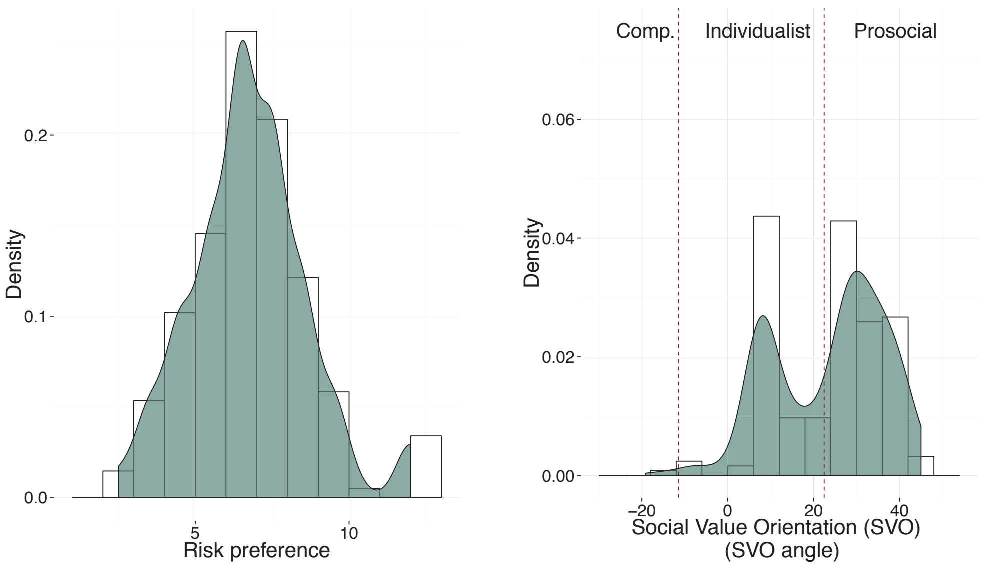


Figure 2.4 Risk preferences and social preferences in the sample



Chapter 3

To Comply or Not to Comply: The Effect of Changes in Standard Variability on Behavior

Abstract: Doctrinal lawyers strive to reduce legal uncertainty based on the premise that socially desirable activities are stifled when legal consequences are difficult to predict. Instead, economic theory of law suggests that increasing legal uncertainty can be socially beneficial. We test in a laboratory experiment whether increasing the variability of an exogenous choice threshold (legal standard) increases or reduces socially desirable behaviour. The results indicate a U-shaped relationship between increases in variability and activity choices: increases in variability first induce choice levels below the optimum (overcompliance), but eventually lead to choices above the optimum (undercompliance). Moreover, increasing variability gradually crowds-out compliant choices. Finally, in the experiment minimal variability of the legal standard induces erratic individual behaviour beyond socially satisfactory levels such that the standard loses its coordination function.

Keywords: legal uncertainty; vague legal standard; overcompliance and undercompliance; experimental law and economics; compliance crowding-out

3.1 Introduction

In settings of legal uncertainty, a person faces difficulties to perfectly predict how a judge or public administration official will apply the law (e.g.: Popelier, 2000; Raitio, 2008). Which legal consequence will realize remains unclear in the sense that possible consequences are associated with some residual probability of occurring. For example, when an informed prediction yields a 90% chance of either winning or losing at trial, how the law will be applied is quite foreseeable. In this case, legal uncertainty is low. By contrast, given a 50%-level of predictability of either outcome, the legal consequence resulting from trial is not at all foreseeable. In this case, legal uncertainty is highest (D'Amato, 1983).

Theoretical conflict exists between doctrinal legal scholars and economists regarding the effects of legal uncertainty on rule-subjected individuals. On the one hand, an argument in doctrinal legal scholarship holds that difficult-to-predict legal consequences can crowd-out socially beneficial activities. This argument relates back to Max Weber's theory on legalism (Trubek, 1972; Weber, 1978). Consequently, doctrinal legal scholars on both sides of the Atlantic advocate reducing legal uncertainty (see e.g.: D'Amato, 1983; Popelier, 2000; Maxeiner, 2006, 2007; Raitio, 2008; Smits, 2012). On the other hand, results from economic theory reveal that increasing legal uncertainty can encourage socially beneficial activities. For instance, increases in the vagueness of a legal standard may reduce excessively compliant behaviour that is inefficient (Craswell and Calfee, 1986). As another example, legal uncertainty can act as selective deterrent that discourages controversial actions while stimulating socially beneficial activities (Lang, 2014). Compared to their lawyer colleagues, economists emphasize optimal rule design and suggest that reducing legal uncertainty at all costs is not desirable.

In this article, we provide insight into the discussion about the effects of legal uncertainty on activity choices in three steps. First, we elaborate on the concept of legal uncertainty that we employ throughout our study. We do so by revisiting Craswell and Calfee (1986)'s model that analyses a person's activity choice under a vague legal standard. The vague legal standard is stochastic in the sense that it is drawn from a known probability distribution. Accordingly, there is a chance of false positives and false negatives, i.e., a court may mistakenly exonerate a noncompliant person or erroneously sanction a compliant person (see also: Kaplow, 1994). Changes in the dispersion of the probability distribution reflect different degrees of standard vagueness. As a result, Craswell and Calfee (1986) predict overcompliance at small degrees of legal vagueness, but that behaviour reverts to efficiency as standards become less predictable. The authors identify a U-shaped relationship between standard vagueness and activity choices such that increases in standard vagueness can actually reduce inefficient overcompliance. Second, we update the model's assumptions about a person's preference structure. We show that the doctrinal perspective on the discussion can be accommodated within the same model. Finally, to falsify either of the ensuing perspectives, we study individual behaviour under vague legal standards in a controlled laboratory experiment.

In the experiment, 137 participants indicated an activity choices by positioning a slider. After their slider choice, we simulate a vague legal standard by drawing a choice threshold from a normal distribution known to the participants. If a participant's slider choice was lower than the choice threshold, she was paid according to a payoff function reflecting her private benefit from the slider choice. If the slider choice was greater than the choice threshold, however, the participant had to return a specified amount of her private benefit and, thus, received a lower payoff than otherwise. To experimentally reflect different degrees of standard vagueness as measure of legal uncertainty, the experiment varied between subjects the standard deviation of the distribution determining the choice threshold. The experiment comprised six treatment groups with increasing degrees of standard vagueness.[1]

Our main results support the standard economic model of Craswell and Calfee (1986): a sufficiently low level of standard vagueness on average induces overcompliance; after a tipping point, however, a further increase of standard vagueness reduces and, eventually, eliminates overcompliant choices. Inefficiently overcompliant choices only obtain under low standard vagueness. Otherwise, activity choices under substantial standard vagueness are statistically indistinguishable from those under near absence of standard vagueness. Moreover, our data reveals important auxiliary results. First, the share of compliant (as opposed to non-compliant) choices gradually reduces with increasing standard vagueness. Second, as soon as standard vagueness exceeds the quasi-certain level, the share of socially desirable (as opposed to socially undesirable) choices sharply drops—to the extent that socially undesirable choices far outweigh socially desirable choices.

[1] Although the notion is contested that data from field experiments is more realistic (e.g.: Falk and Heckman, 2009), we acknowledge that the advantages of controlled laboratory experiments may come at the price of reduced external validity.

With this chapter, we primarily contribute to previous research on negligence liability (e.g.: Shavell, 1980; Landes and Posner, 1981; Kahan, 1989), in general, and on the effect of vague legal standards (e.g.: Craswell and Calfee, 1986; Lang, 2014), in particular. In this respect, we provide experimental evidence on how standard vagueness affects the activity choice.

In addition, our study relates to other research streams. First, our results speak to different contributions in the deterrence literature. The deterrence hypothesis involves that criminal actions decrease in the probability of punishment (seminal: Becker, 1968). Experimental tests of the deterrence hypothesis mostly uncover confirmatory evidence (e.g.: Abbink, Irlenbusch, and Renner, 2002; DeAngelo and Charness, 2012; Rizzolli and Stanca, 2012; Schildberg-Hörisch and Strassmair, 2012; Khadjavi, 2015). These studies, however, only use point values as exogenous detection probabilities. By contrast, we employ an endogenous and dynamic detection probability that depends on a person's choice. Thereby we allow potential offenders to self-select into a tolerable detection probability. In addition, our study is not driven to achieve maximum deterrence, but rather optimal deterrence. Moreover, regarding deterrence researchers have suggested that accuracy is a method of increasing deterrence because fewer legal errors increase the disincentives to commit harmful acts (e.g. Kaplow, 1994; Polinsky and Shavell, 1989). Our results, however, indicate a non-monotonic relationship between accuracy and activity choice. Second, our results provide novel experimental evidence for the rules versus standards debate. A common argument is that *ex ante* uncertainty endemic in standards can lead to undesirable behaviour. Specifically, risk-averse persons may forego socially desirable actions when exposed to an uncertain standard (e.g.: Kaplow, 1992; Korobkin, 2000). Our results indicate that the amount of foregone actions depends on the degree of standard vagueness. In fact, even after controlling for risk attitudes our participants do not significantly forego desirable actions in any treatment. Thus our results invalidate the argument against using standards in lieu of rules.

Section 3.2 derives predictions based on a formal model. Section 3.3 discusses the experimental design. Section 3.4 analyses the the data and reports the ensuing results. Section 3.5 discusses our findings before Section 3.6 concludes.

3.2 Theory & predictions

We derive predictions from a formal model that builds upon previous work of Craswell and Calfee (1986). We start by setting up the model and reviewing Craswell and Calfee (1986)'s results. We then add behavioural modifications to the original model.

Suppose a rational, fundamentally self-interested person can engage in an activity x with $x \in [0, \bar{x}]$, where $\bar{x}$ is some upper natural or technological boundary. Exercising activity x is profitable for the person. Let $b(x)$ represent these benefits and assume $b(x)$ to be twice differentiable and concave, i.e., $b'(x) > 0$, $b''(x) \leqslant 0$. Moreover, engaging in activity x imposes costs on others. Let $e(x)$ denote this negative externality and assume $e(x)$ to be twice differentiable and convex, i.e., $e'(x) > 0$, $e''(x) \geqslant 0$.

Further suppose a lawmaker or judge wants to regulate activity x by setting a legal standard x_L with $x_L < \bar{x}$. The legal standard x_L is a maximum standard: when a person chooses $0 \leqslant x \leqslant x_L$ she is compliant; when she chooses $x_L < x \leqslant \bar{x}$ she violates the legal standard. For instance, think of x_L as a speed limit, maximum working hours per week, or a cap on noise pollution. Moreover, assume that courts will hold a person violating x_L fully liable for the costs that her choice of x imposes on others. When non-compliant, she has to pay damages $d(x)$ that perfectly compensate for the negative externality, i.e., $d(x) = e(x)$.[2]

Assume that the legal standard is set at the amount of activity x that maximizes social welfare, i.e., $x_L = x_S$. Formally, x_S solves the problem $\max_x \big[b(x) - e(x)\big]$ and thus satisfies the condition $b'(x) = e'(x)$. Following Craswell and Calfee (1986), we can thus define over- and undercompliance relative to the socially optimal amount of activity x. When a person chooses $x < x_S$, from a societal perspective she practices too little of activity x. She is overcompliant. Conversely, when a person chooses $x > x_S$, she carries out too much of activity x. She is undercompliant. Both overcompliance and undercompliance are socially undesirable because any choice $x \neq x_S$ leads to a welfare loss.

At least since Brown (1973), negligence models mostly assume legal certainty in that they rely on a precise, deterministic legal standard (e.g.: Shavell,

[2] Because $d(x) = e(x)$, for the remainder of the chapter we will not further differentiate between damages and external costs and use $e(x)$ for convenience.

1980; Landes and Posner, 1981; Grady, 1983; Kahan, 1989). By contrast, we model a stochastic legal standard to represent standard vagueness as one variety of legal uncertainty. A person who chooses x knows that with increasing x there is the probability $P(x_L < x) = F(x)$, with $F'(x) > 0$, that a court will hold her in violation of the legal standard. Conversely, with probability $P(x_L \geqslant x) = 1 - F(x)$ a court will find a person in compliance with the legal standard. While the standard is objectively determined ex post by judges or administrative officials, the stochastic nature of the ex ante perception of x_L may result from the varying and possibly erroneous interpretation of the standard. Ex ante the standard is therefore perceived as vaguely distributed around a most likely mean. Formally, assume that $F(x)$ is a cumulative distribution function with

$$F(x) \equiv \int_0^x f(t)\, dt,$$

where $f(x) \equiv F'(x)$ is the associated probability density function. As functional form, we assume that x_L is normally distributed around the socially optimal level x_S, i.e., $x_L \sim \mathcal{N}(x_S, \sigma)$,[3]. Thus we denote the ensuing probability as $\Phi(x)$ and its first derivative as $\phi(x)$.

This modelling step corresponds with the way in which legal scholars have conceptualized legal uncertainty. Legally relevant decisions concern an informed prediction of how the courts will apply the law when presented with some dispute (cf.: Holmes, 1897; Popelier, 2000; Raitio, 2008). Legal uncertainty thus creates a prediction problem and legal uncertainty can be understood as a

> "situation that obtains when the rule that is relevant to a given act or transaction is said [...] to have an expected [...] outcome at or near the 0.5 level of predictability" (D'Amato, 1983, p. 2).[4]

[3] As a robustness check, Figure 3.5 in 3.7.1 illustrates predictions when x_L is uniformly distributed. Changing the underlying distribution does not change the basic analytical results and hypotheses.

[4] This needs to be clearly differentiated from another, operationally different definition of legal uncertainty. Legal uncertainty can be understood as a situation that emerges when the legal system contains at least one legal problem whose correct solution is undeterminable, e.g., a case that cannot be decided in an identifiably and uniquely correct way. In this sense, Dworkin (1977, p. 286) speaks of "ties".

In this sense, a legal rule affects a person's behaviour to the extent that the person perceives the uncertainty of being found in violation or in compliance with the rule. In the present model, a higher σ implies a larger interval around the legal standard $x_L = x_S$ that yields a prediction close to the 0.5 level of being found either violating or complying with the legal standard. Put differently, the location of the legal standard becomes less predictable with increasing σ. Measures of dispersion of the underlying probability distribution of the legal standard then reflect the degree of standard vagueness and legal uncertainty.

As we assume that probability distributions are known, our approach to modelling "legal uncertainty" is incommensurate with how economists think about uncertainty. Economists understand uncertainty as risk that is immeasurable: an event is uncertain if it may or may not happen in the future and the probabilities of the event occurring or not are unknown (Knight, 1921). Technically, this model of legal uncertainty concerns risky decision-making because probabilities are known for each choice x. This approach is in line with the conceptualization of legal uncertainty in legal scholarship, however. Moreover, recent research in law and economics not only studies legal uncertainty as Knightian uncertainty (e.g.: Schildberg-Hörisch and Strassmair, 2012) but also utilizes known probability distributions (e.g.: Lang, 2014).

3.2.1 Standard preferences & risk-neutral persons

To specify a person's preference structure, we initially consider a risk-neutral person who derives utility from her choice of x according to the utility function

$$u_{RN}\big(x\big) = \begin{cases} b(x) & \text{for } x \leqslant x_L \text{ (compliance)} \\ b(x) - e(x) & \text{for } x > x_L \text{ (violation)} \end{cases} . \tag{3.1}$$

As outcome $x > x_L$ occurs with probability $\Phi(x)$, for any choice of x her expected utility is

$$U_{RN}\big(x\big) = b(x) - \Phi(x)\ e(x). \tag{3.2}$$

Because we assume utility to be piecewise linear in wealth, $U_{RN}\big(x\big)$ coincides with the expected value of net benefits. This formulation is equal to the original optimization problem of Craswell and Calfee (1986)'s risk-neutral agent. This congruence deserves emphasis because Craswell and Calfee (1986) did not make their agent's utility function explicit – with important consequences for the extension to risk-averse agents (see 3.7.2).

To understand a risk-neutral person's incentives at the socially optimal level x_S, we differentiate $U_{RN}\big(x\big)$ with respect to x

$$\frac{\partial U_{RN}\big(x\big)}{\partial x} = b'(x) - \phi(x)\; e(x) - \Phi(x)\; e'(x) \tag{3.3}$$

and evaluate this result at the social optimum x_S where $b'(x) = e'(x)$

$$\frac{\partial U_{RN}\big(x\big)}{\partial x}\bigg|_{x_S} = \big(1 - \Phi(x_S)\big)\; b'(x_S) - \phi(x_S)\; e(x_S). \tag{3.4}$$

The first term of expression (3.4) describes the gains for the potential defendant from marginally increasing x. The marginal benefits are discounted by the probability $1 - \Phi(x_S)$ that a person is found compliant. The second term of expression (3.4) represents the offsetting effect identified by Craswell and Calfee (1986). Marginal increases in x also increase the probability of being held liable. A utility maximizing person has an incentive to choose an individually optimal amount $x^* < x_S$ (overcompliance) when expression (3.4) is negative and an incentive to choose an individually optimal level $x^* > x_S$ (undercompliance) when expression (3.4) is positive.

As a formal extension to Craswell and Calfee (1986), we derive from (3.3) the effect of standard vagueness on a person's optimal choice x^*_{RN} by

$$\frac{\partial U_{RN}\big(x^*_{RN}\big)}{\partial x^*_{RN}} \stackrel{!}{=} 0$$

and get $x^*_{RN} = x^*_{RN}(\sigma)$.[5] That is, the individually optimal choice x^*_{RN} is a function of the vagueness measure σ. The response function describes a risk-neutral person's optimal choice given a specific degree of standard vagueness.

[5] A mathematical solution to derive $x^*_{RN}(\sigma)$ is not possible because $\Phi(x)$ has no closed form representation. Therefore, we simulate the different response functions in Figure 3.1 using the software environment R. For specification and parametrization of all underlying functions, see 3.7.3.

The dashed line in Figure 3.1 on page 33 illustrates the relation between x^*_{RN} and σ. The ordinate of the graph in Figure 3.1 represents the individually optimal choice x^* relative to the socially optimal level x_S and the legal standard x_L. The abscissa of the graph represents σ as a measure of vagueness of the legal standard. The response function $x^*_{RN}(\sigma)$ resembles the characteristic pattern identified by Craswell and Calfee (1986): a sufficiently low level of σ initially induces overcompliance; an increase of standard vagueness beyond a tipping point, however, reduces overcompliance; eventually, overcompliance turns into undercompliant individually optimal choices. Two noteworthy results emerge. First, reducing standard vagueness does not necessarily improve the compliance decision. The difference between x^* and x_S describes how much individually optimal behaviour deviates from socially optimal behaviour. Despite a reduction in standard vagueness, this difference increases when standard vagueness is sufficiently high.[6] Second, a specific degree of standard vagueness $\sigma^* > 0$ leads to socially optimal compliance decisions, i.e., $x^*_{RN}(\sigma^*) = x^*_{RN}(0) = x_S$. When a precise standard is impossible to implement, the existence of σ^* implies that increasing (reducing) the degree of standard vagueness can be socially beneficial given initially overcompliant (undercompliant) behaviour.

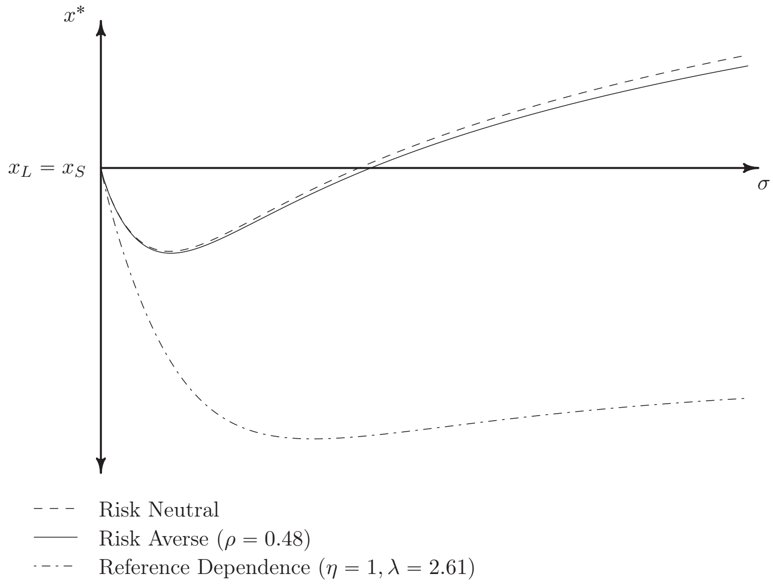
3.2.2 Standard preferences & risk-averse persons

We are interested in the behavioural consequences of legal uncertainty and extend the analysis by gradually incorporating or modifying assumptions about how a person decides. Our first behavioural modification concerns risk attitude. Instead of assuming that a person is risk-neutral, we assume that a person exhibits risk aversion. We continue to model society as risk-neutral regarding the social benefits and costs from activity x. Therefore, the socially optimal amount x_S remains unchanged.[7]

[6] Given a reduction in σ, the difference between x^* and x_S may especially increase when the legal standard is not distributed around the socially optimal level. See Craswell and Calfee (1986) for an extensive analysis within the risk-neutral framework. We do not test this case.

[7] We deviate here from Craswell and Calfee (1986) who assume that society is only risk-neutral regarding the social costs of a person's activity and that, therefore, x_S is determined by solving $\max_x\big[u\big(b(x)\big)-e(x)\big]$. This assumption strikes us as inconsistent. If one evaluates $b(x)$ through the utility function of the person choosing x, one should consistently evaluate $e(x)$ through the utility function of the person suffering the external cost. Moreover, risk preferences in society are heterogenous. A regulator will hardly be able to specify an aggre-

Figure 3.1 Over- and undercompliance for different preference structures



Consider a rational, fundamentally self-interested person that is averse to risk. She has a twice differentiable utility function $u(\cdot)$ with $u'(\cdot) > 0$, $u''(\cdot) < 0$ (concavity). As her utility over absolute income depends on her choice of x, she derives utility from

$$u_{RA}(x) = \begin{cases} u\big(b(x)\big) & \text{for } x \leqslant x_L \text{ (compliance)} \\ u\big(b(x) - e(x)\big) & \text{for } x > x_L \text{ (violation)} \end{cases}. \tag{3.5}$$

Differentiating her expected utility with respect to x and evaluating this result at the social optimum x_S where $b'(x) = e'(x)$ yields

gate risk preference that sufficiently takes into account all idiosyncrasies of members of said society. Instead, we adopt the idea of a rationality default (Schwartz, 2015): when the facts are unobtainable or ambiguous, regulators should refrain from behavioural assumptions. This approach is “autonomy preserving, administrable, and coherent” (Schwartz, 2015, p. 1). The coherent application of the risk-neutral standard x_S is also experimentally motivated: in the experiment we only define one activity benchmark for all participants instead of a specific activity benchmark for each participant given her *ex ante* elicited utility function.

$$\left.\frac{\partial U_{RA}(x)}{\partial x}\right|_{x_S} = \big(1 - \Phi(x_S)\big)\, u'\big(b(x_S)\big)\, b'(x_S) \\ - \phi(x_S)\big[u\big(b(x_S)\big) - u\big(b(x_S) - e(x_S)\big)\big]. \tag{3.6}$$

Expression (3.6) is similar to the risk-neutral case in expression (3.4). The first term describes the gains for a risk-averse person of marginally increasing x if found compliant ($x \leqslant x_L$). The second term represents the offsetting effect that marginal increases in x also increase the probability of being held liable ($x > x_L$). This marginal increase is weighted by the opportunity cost of being found violating the legal standard. Similar to expression (3.4), a person has an incentive to choose $x^* < x_S$ when expression (3.6) is negative Conversely, she has an incentive to choose $x^* > x_S$ when expression (3.6) is positive.

Analogous to the risk-neutral case, we obtain a risk-averse person's optimal choice x^*_{RA} by simulating the response function $x^*_{RA}(\sigma)$. The solid line in Figure 3.1 depicts this response function. $x^*_{RA}(\sigma)$ shows a pattern very similar to $x^*_{RN}(\sigma)$: standard vagueness initially induces overcompliance but, as vagueness increases just enough, overcompliance will turn into undercompliance. Moreover, Figure 3.1 reveals that $x^*_{RA}(\sigma) < x^*_{RN}(\sigma)$ over the entire range of σ. This result suggests that the domain of overcompliance is larger and that overcompliance is more severe compared to the risk-neutral case. By contrast, the domain of undercompliance is smaller and undercompliance is less severe. Craswell and Calfee (1986, p. 301) also find that risk aversion increases the likelihood of overcompliance. Compared to their result, however, the effect of risk aversion in the present model is much less pronounced. This difference is driven by an implicit assumption of Craswell and Calfee (1986, p. 301). In addition to risk aversion, they assume asset isolation. Under this assumption a person separates different payoff streams and computes utility for each of the payoffs separately. By contrast, the present model assumes asset integration: a person first computes final wealth and then evaluates final wealth through her utility function. 3.7.2 elaborates on this difference.

3.2.3 Reference-dependent preferences

Our second modification changes the assumption on how individuals evaluate outcomes. We incorporate into the model another empirically established finding about human behaviour: hedonic consequences of outcomes depend not only on absolute outcomes, but also on how these outcomes change relative to a reference point (cf.: Barberis, 2013). Reference-dependent preferences successfully explain observed behaviour that is seemingly at odds with standard economic predictions. For instance, reference-dependent preferences are useful to understand why taxi drivers stop working when their earnings are unexpectedly high (Camerer, Babcock, Loewenstein, and Thaler, 1997; Crawford and Meng, 2011), why sellers overprice their property when facing nominal losses in a real-estate crisis (Genesove and Mayer, 2001), and why contestants increase effort in contests with a higher proportion of winners than losers than in contests designed to yield less winners than losers (Lim, 2010). In the legal context, reference-dependent preferences, e.g., help explain why defendants are more reluctant than plaintiffs to accept settlement offers (Rachlinsky, 1996) and why plaintiff's prefer contingent contracts, whereas defendants prefer to pay their attorneys fixed hourly fees (Zamir and Ritov, 2010).

Specifically, we build upon Kőszegi and Rabin (2006, 2007)'s modelling framework. Let overall utility over some good y consist of an absolute, purely outcome-based utility component $m\big(y\big)$ and a relative, reference-dependent gain-loss utility component $\mu\big(y - r\big)$. While the former term describes the intrinsic utility a person obtains from y, the latter term describes how a person feels about changes in utility obtained from y relative to r. Formally, overall utility is

$$u\big(y \,\big|\, r\big) \equiv m\big(y\big) + \eta\, \mu\big(y - r\big).$$

Parameter $\eta \geqslant 0$ weighs the importance of gain-loss utility relative to outcome-based utility. Without loss of generality, we assume $\eta = 1$ for the remainder of the chapter. We further assume that a person's absolute utility $m(\cdot)$ is unbounded, strictly increasing, and (weakly) concave, i.e., $m'(\cdot) \geqslant 0$ and $m''(\cdot) \leqslant 0$.

Gain-loss utility $\mu(\cdot)$ satisfies the implicit or explicit assumptions about the value function in prospect theory (see: Kahneman and Tversky, 1979; Tversky and Kahneman, 1992; Kőszegi and Rabin, 2006). The gain-loss utility function $\mu(y - r)$ is

$$\mu(y - r) \equiv \begin{cases} m(y - r) & \text{for } y \geqslant r \\ -\lambda m\big(-(y - r)\big) & \text{for } y < r \end{cases}. \tag{3.7}$$

Parameter $\lambda \geqslant 1$ describes how much the agent weighs losses relative to gains. When $\lambda > 1$, $\mu(\cdot)$ is steeper for losses than for gains, i.e., the person is loss averse. Moreover, $m(\cdot) \equiv (\cdot)^{\alpha}$, where parameter α measures diminishing sensitivity of the gain-loss utility function. We assume $0 < \alpha < 1$ such that $\mu(\cdot)$ is concave in the gain domain and convex in the loss domain. This assumption is also consistent with the assumptions about the absolute utility component $m(\cdot)$.

To specify the context at hand, let a person derive utility from monetary income, i.e., $y = w(x)$. Similar to expression (3.2), a person's monetary income $w(x)$ results from a gamble $(b(x),\, 1 - \Phi(x);\, b(x) - e(x),\, \Phi(x))$. That is, final wealth is stochastic.

The definition of the reference point r is crucial to predict behaviour. Starting with Kahneman and Tversky (1979), most models of reference-dependent preferences equate the reference point with the status quo. In this sense, reference points are mostly deterministic and fixed exogenously. Consistently following Kőszegi and Rabin (2006, 2007), we assume a non-deterministic reference point that is formed by a person's lagged expectations about relevant outcomes of her choice. Intuitively, when a person codes recent beliefs about outcomes as a reference point, she evaluates any realized outcome by comparing it to all possible outcomes. Each comparison is weighted by the *ex ante* probability that the alternative outcome occurs. Moreover, let individuals form fully rational expectations: a person correctly predicts her choice set, how her choice influences the distribution of possible outcomes, and her hedonic response.

From her choice of x a person with expectation-based reference-dependent preferences derives utility

$$u_{KR}(x) = \begin{cases} m\big(b(x)\big) + \Phi(x)\, m\big(e(x)\big) & \text{for } x \leqslant x_L \text{ (compliance)} \\ m\big(b(x) - e(x)\big) - \big(1 - \Phi(x)\big)\, \lambda\, m\big(e(x)\big) & \text{for } x > x_L \text{ (violation)} \end{cases} . \tag{3.8}$$

Intuitively, if a court finds a person compliant ($x \leqslant x_L$), the person experiences absolute utility $m\big(b(x)\big)$ from the private benefits of her choice x. Moreover, she experiences an additional utility $\Phi(x)\; m\big(e(x)\big)$ from the comparison of the actual outcome compared to the counterfactual violation of x_L (gain). Conversely, if a court holds a person liable ($x > x_L$), she generates utility from her private benefits less the compensation payment $m\big(b(x) - e(x)\big)$. Further, she experiences an additional disutility $\big(1 - \Phi(x)\big)\ \lambda\ m\big(e(x)\big)$ relative to the expectation of being found compliant with x_L (loss).

Differentiating her expected utility with respect to x and evaluating the result at the socially optimal level x_S, where $b'(x) = e'(x)$, yields

$$\begin{aligned}\frac{\partial U_{KR}(x)}{\partial x}\bigg|_{x_S} = &\big(1 - \Phi(x_S)\big)\ m'\big(b(x_S)\big)\ b'(x_S)\\ &- \phi(x_S)\ \Big[m\big(b(x_S)\big) - m\big(b(x_S) - e(x_S)\big)\Big]\\ &+ \phi(x_S)(\lambda - 1)\ \Phi(x_S)\ m\big(e(x_S)\big)\\ &- \big(1 - \Phi(x_S)\big)\ (\lambda - 1)\ \Big[\phi(x_S)\ m\big(e(x_S)\big) + \Phi(x_S)\ m'\big(e(x_S)\big)\ e'(x_S)\Big].\end{aligned} \tag{3.9}$$

The first and second term describe absolute effects from marginally increasing x similar to expression (3.6). For $x \leqslant x_L$ the decision-maker obtains a marginal benefit that is discounted by the probability $1 - \Phi(x_S)$ but he also bears the opportunity costs for $x > x_L$ as $\Phi(x_S)$ marginally increases. Due to reference dependence, we find two additional effects. As the third term describes, marginally increasing the likelihood of $x > x_L$ (violation) also increases the potential gain experience if this outcome is not realized. The fourth term captures that marginally increasing x, however, also threatens an increased loss when violating x_L. This countervailing effect is discounted by $1-\Phi(x)$. Again, a person has an incentive to choose $x^* < x_S$ when expression (3.9) is negative. Conversely, she has an incentive to choose $x^* > x_S$ when expression (3.9) is positive.

We obtain the optimal choice x^*_{KR} by simulating the response function $x^*_{KR}(\sigma)$ analogous to the risk-neutral and the risk-averse case. The dot-dashed line in Figure 3.1 depicts the ensuing relationship. Under expectation-based reference-dependent preferences, an increase in standard vagueness σ leads to a rapid drop of the individually optimal choice (overcompliance). However, $x^*_{KR}(\sigma)$ exhibits a much less pronounced tipping point. After the initial drop, the extent of overcompliant behaviour does not decrease substantially with increasing standard vagueness. We infer from expressions (3.9) and (3.6) that the difference between $x^*_{KR}(\sigma)$ and $x^*_{RA}(\sigma)$ depends on the loss aversion parameter λ because both expressions are equal when $\lambda = 1$. Depending on the specific definition, the elicitation method, and the estimation approach, estimates of the loss aversion coefficient take on values from 1.43 to 4.8 (cf.: Abdellaoui, Bleichrodt, and Paraschiv, 2007; Abdellaoui, Bleichrodt, and L'Haridon, 2008). Despite this volatility, the canonical value as reported by Tversky and Kahneman (1992) is $\lambda = 2.25$ and researchers commonly embrace $\lambda \approx 2$ as a rule of thumb (e.g.: Hossain and List, 2012). For all these specifications of λ our simulations indicate that $x^*_{KR}(\sigma) < x_S$ over the entire range of σ. That is, any amount of standard vagueness induces overcompliance. Importantly, this analytical result resonates with the argument from legal scholarship that legal uncertainty undermines socially beneficial activities and inhibits economic development.

3.2.4 Summary & hypotheses

The theoretical conflict between doctrinal legal scholarship (e.g.: D'Amato, 1983; Maxeiner, 2007; Smits, 2012) and economic theory of law (e.g.: Calfee and Craswell, 1984; Craswell and Calfee, 1986; Lang, 2014) about the effects of legal uncertainty is by no means trivial academic finger wrestling. We modelled legal uncertainty as vague standard in a simple negligence model. The formal analysis supports both views depending on the set of assumptions about how persons decide. Given a person's preference structure, the model thus generates equivocal predictions about the behavioural consequences of vague standards. The equivocal predictions call for experimental testing.

We formulate our research hypotheses in line with the findings in law and economics. Calfee and Craswell (1984) and Craswell and Calfee (1986) propose that, as standard vagueness σ increases, a person's activity choice first decreases and then increases again. We obtain the same result from our expected utility model for risk neutral and risk averse agents (see Figure 3.1). Therefore, we hypothesize:

> **Hypothesis 1:** As standard vagueness σ increases, activity choices first decrease and then increase again. That is, the relation between standard vagueness and activity choice designates a U-shape.

Moreover, the U-shape between standard vagueness and activity choice implies that overcompliant behaviour is more likely to be observed under lower degrees of standard vagueness than under higher degrees of standard vagueness. Overcompliant behaviour will thus more easily emerge at low levels of standard vagueness as opposed to high levels of standard vagueness. We thus we also include a a hypothesis on the location of behavior, as compared to the relative position at different levels of standard vagueness:

> **Hypothesis 2:** Overcompliant behaviour will emerge at low levels of standard vagueness and not at high levels of standard vagueness.

3.3 Experimental design

3.3.1 Task & treatments

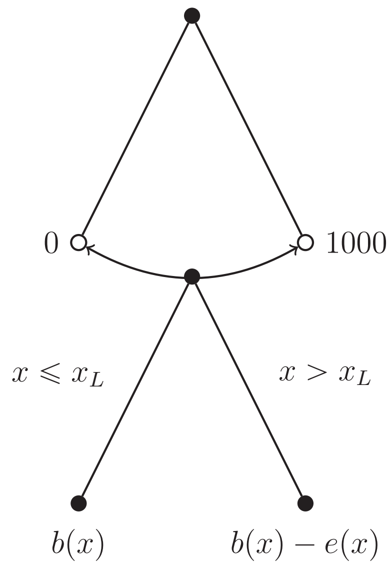
To emulate the theoretical problem in the laboratory, the main task of the experiment consisted of two stages. Figure 3.2 illustrates the main task. In the first stage, participants chose an "activity level" between 0 and 1000 units on a continuous slider (slider choice x). We randomized the initial slider position because a fixed initial position potentially anchors, and thereby systematically distorts, participants' slider choice.

In the second stage, a random draw determined a choice threshold x_L. This random draw was defined by a normal distribution. Across all treatments, the mean of the normal distribution was set to 500.[8] To represent different degrees of standard vagueness, treatments only differed in the standard deviation σ of the normal distribution. Altogether, the experiment comprised $i = 1, ..., 6$ treatments with $\sigma_i \in \{1, 100, 200, 300, 400, 500\}$. Accordingly, the names of the treatments are SD001, SD100, SD200, SD300, SD400, and SD500. The experiment employed a between-subjects design: participants were randomly assigned to only one treatment.

After the draw of the choice threshold, the program compared a participant's slider choice with the choice threshold to determine her payoff. If a participant chose a slider position less than or equal to the choice threshold

[8] Given our parametrization, a slider position of 500 corresponds to the social optimum x_S in the theoretical model. Therefore, setting the mean of the normal distribution to 500 reflects the idea that a regulator sets an efficient legal standard.

Figure 3.2 Game representation of the main task



(compliance: $x \leqslant x_L$), she would gain the payoff $b(x)$ in experimental currency units (ECU). If her slider choice was greater than the choice threshold (violation: $x > x_L$), however, she only received the reduced payoff $b(x) - e(x)$ in ECU. The parametrization of the task corresponds to Craswell and Calfee (1986)'s specifications used in their Table 1.[9] Specifically, participants' payoffs given the slider choice were

$$\Pi(x) = \begin{cases} b(x) = 50\,ln(x) & \text{for } x \leqslant x_L \text{ (compliance)} \\ b(x) - e(x) = 50\,ln(x) - 0.1x & \text{for } x > x_L \text{ (violation)} \end{cases}.$$

Participants' slider choices were incentivized and translated from ECU to EUR with a conversion rate of 0.03. Altogether, the main task consisted of six repetitions of these two stages to capture potential learning effects.

A graphical interface providing information for the slider choice accompanied the choice task. First, over the entire range of the slider, participants

[9] The same mathematical specifications determine the response functions in Figure 3.1.

received a graphical representation of the probability that their slider choice would exceed the choice threshold. This representation corresponded to the cumulative density function underlying the random draw of the choice threshold. Second, the interface showed a graphical representation of the slider-choice-dependent payoff, both for the event that a participant's slider choice was smaller than or equal to the choice threshold and for the event that the slider choice exceeded the choice threshold. Third, the interface also provided information about the potential consequences of the current slider position to further increase salience of the payoffs, the probabilities of each event occurring, and their dependence on the slider position. We conveniently clarified the payoffs and probabilities for each event right next to the corresponding graphical payoff representation. Thus, for any slider position, participants could see the specific payoffs and the associated probabilities. As people frequently struggle with numerical probability descriptions (cf.: Cokely, Galesic, Schulz, and Ghazal, 2012; Peters, 2012), the interface also depicted the specific probabilities in a pie chart varying with the slider position. We kept the choice interface predominantly graphical. The experiment aimed at creating the least abstract choice environment while preserving as much control as possible. Figure 3.7 in 3.7.4 depicts a sample decision screen from the experiment.

After the main task, we conducted two incentivized post-tests relevant to the theoretical predictions. The first post-test elicited risk preferences following a multiple price list (MPL) approach (Holt and Laury, 2002; Gneezy, Imas, and List, 2015). The second post-test elicited participants' preferences over gains and losses (Abdellaoui, Bleichrodt, and L'Haridon, 2008).

3.3.2 Procedure & sample

The experiment was conducted in January 2015 in the experimental laboratory of Friedrich Schiller University Jena. Altogether, 137 student subjects participated in the experiment.[10] Table 3.1 contains further information about the sample. Upon arrival at the lab, participants were randomly allocated to their cubicle and their treatment group by drawing a number from an urn. The experiment comprised eight sessions with three treatment groups each, i.e., SD001, SD100, SD200 in sessions 1-4 and SD300, SD400, SD500 sessions 5-8.

[10] We programmed the experiment with z-Tree (Fischbacher, 2007) and we recruited participant with ORSEE (Greiner, 2015).

Table 3.1: Sample statistics per treatment and overall

		SD001	SD100	SD200	SD300	SD400	SD500	overall
# participants		24	24	21	24	24	20	137
% participants		17.52	17.52	15.33	17.52	17.52	14.60	100.00
% female		58.33	50.00	66.67	58.33	45.83	50.00	54.74
# Age (avg.)		25.44	26.24	25.24	25.78	25.18	26.67	25.74
field of study:	law	0	3	5	0	1	3	12
	economics	4	4	4	5	3	4	24
	natural science	3	6	3	6	5	5	28
	other	17	11	9	13	15	8	73

Because the choice in the main task was complex and participants confronted probability distributions, they received video instructions instead of mere textual instructions. The 11 minute video provided detailed information about the functionality of and the information displayed on the graphical interface, about the payoff structure, about the choice threshold, and about the probability distributions underlying its determination.[11] The instructions and the choice interface contained neutral language to avoid contextual associations and label effects. To ensure that participants understood the video instructions, they had to correctly answer a set of control questions. Without a correct answer, they could not advance to the main task. After the main task, participants completed the two post-tests. All sessions lasted approximately 45 minutes.

At the end of each session, one of the eight rounds—six rounds in the main task and two post tests—was randomly selected for payment. Altogether, participants received a payment between 6.30 EUR and 15.10 EUR including a show-up fee. Participants earned 8.70 EUR on average.

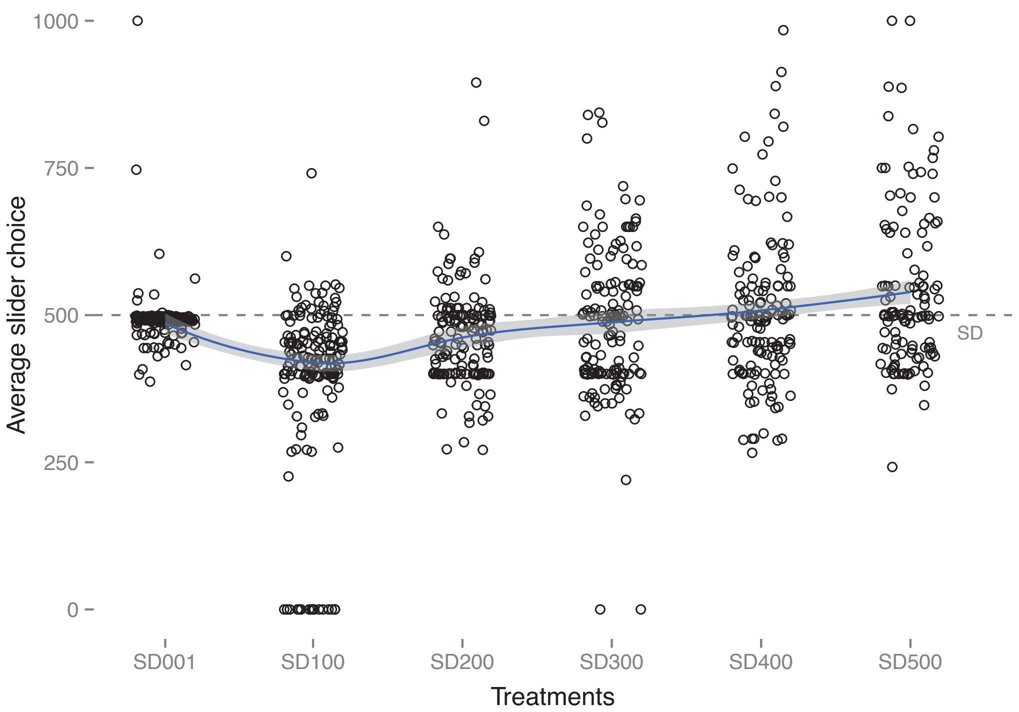
3.4 Analysis & Results

Hypothesis 1 holds that the relation between standard vagueness and activity choice designates a U-shape. In terms of our experiment, we predict that

[11] Video instructions for a sample treatment can be viewed through this link: https://www.dropbox.com/sh/ebox9bgwr3kd4an/AABsUKtL44Ng4QI4aqtX19-la?dl=0 .

slider choices of participants will first decrease and then increase as treatments progress from SD001 to SD500. Figure 3.3 depicts the slider choices of each participant conditional on treatment and the smoothed conditional mean across treatments. In line with Hypothesis 1 the smoothed conditional mean in Figure 3.3 suggests a U-shaped relationship between increasing variability of the choice threshold and participants' average slider choice.

Figure 3.3 Individual slider choices by treatment



Note: Observations are jittered horizontally to increase visibility.
Smoothing method: loess, fraction of points used to fit each local regression: 0.8

To confirm the observation from Figure 3.3 we regress our treatment variable as a linear term and as a quadratic term on the participants' slider choice. As we have multiple responses per subject and thus need to resolve non-independence, we estimate the following mixed effects model with random intercepts:

$$\mathsf{slider}_{ij} = \beta_{0j} + \beta_1\,(\mathsf{SD}^2_{ij}/100) + \beta_2\,\mathsf{SD}_{ij} + \epsilon_{ij}.$$

To properly center the estimation of the parabola, we deducted the mean (250) from our treatment variable, this has the added benefit of reducing the correlation between the linear and the squared term. Moreover, maximum-likelihood estimators can have problems when some predictor variables are much larger than others. As a precaution, we thus rescaled the quadratic treatment variable by dividing it by a constant.

Table 3.2 reports the results from the estimation. The positive and significant coefficient of the quadratic term (Likelihood Ratio test: $\chi^2 = 2.839$, $p = 0.092$) confirms the convexity observed in Figure 3.3. The coefficient of the linear term is slightly positive but close to zero and significant coefficient of SD (Likelihood Ratio test: $\chi^2 = 8.979$, $p = 0.003$). This indicates the presence of a U-shape with a slight positive linear trend. We also conclude that the participants' slider choices at the highest level of variability are larger than at the lowest level of variability.

Table 3.2: Convexity of slider choice

	(Intercept)	$\mathrm{SD}^2/100$	SD
coefficient	460.517***	0.067*	0.181***
(st.error)	(14.899)	(0.040)	(0.060)

*: $p < 0.10$; **: $p < 0.05$; ***: $p < 0.01$.

Result 1 (U-shape): With increasing variability of the choice threshold, participants' slider choices conform to a U-shape.

The results in Table 3.2 also inform the analysis of Hypotheses 2. Hypothesis 2 holds that overcompliant behaviour will emerge at low levels of standard vagueness. Given the parametrization in the experiment, the choice threshold under certainty is 500. This would also be the socially optimal amount derived as a benchmark from the theoretical model. Consequently, overcompliant choices are slider choices less than 500. In Table 3.2, the lower-than-500 intercept suggests that, on average, slider choices are lower than 500 (overcompliance) at the lowest level of standard vagueness, with the regressor coefficients suggesting that the activity level gradually increases.

To commence testing Hypothesis 2, we use a series of one-sample Wilcoxon signed-rank tests conditional on treatment. Table 3.3 reports the results. We reject the null hypothesis that the true location of the average slider choices is larger than or equal to 500 only for treatments SD001, SD100, and SD200. By contrast, average slider choices in SD300, SD400, and SD500 are not significantly below the 500-mark. Figure 3.3 illustrates that this result is not a mere artefact of a lack of observations in the overcompliance domain. As in SD300, SD400, and SD500 participants on average chose a slider position that was not significantly below the 500-mark, we conclude overcompliant behaviour emerged at lower levels but not at higher levels of variability of the choice threshold.

Table 3.3: Overcompliance conditional on treatment

Treatment	Average choice	Test statistic (V)	P-value
SD001	492.56	59	0.004
SD100	393.86	5	< 0.000
SD200	461.89	34	0.003
SD300	487.76	124.5	0.239
SD400	504.17	150	0.506
SD500	540.32	139	0.899

Note: Results from one-sided, one-sample Wilcoxon signed-rank tests for overcompliance.

To extend the analysis of Hypothesis 2, we estimate treatment effects on slider choice with a linear model. SD100 to SD500 enter the estimation as treatment dummies while SD001 is the reference treatment. As before, we resolve non-independence between within-subject observations by adding a random effect on the subject level. Model 1 in Table 3.4 reports the results. The simple model with treatment dummies and random intercepts at the participant level (model 1) shows that SD100 has a significant and substantial negative effect on the slider choice (Likelihood Ratio test: $\chi^2 = 5.462$, $p = 0.019$)

relative to SD001. Participants' slider choice in treatments with higher variability was not significantly different from participants' slider choice in SD001. Relative to quasi-certainty in SD001, this result suggests overcompliance in SD100 but not in the other treatments. In a second estimation, we additionally control for risk preference, gain-loss preference, age, and gender (Table 3.4, Model 2).[12] While an increase of participants' risk attitude measure has a strong and significant negative effect on their slider choices (Likelihood Ratio test: $\chi^2 = 9.806$, $p = 0.002$), the negative effect of SD100 relative to SD001 remains significant (Likelihood Ratio test: $\chi^2 = 4.093$, $p = 0.043$). Neither the other control variables nor the treatments with higher variability have a significant effect on participants' slider choice. Thus after controlling for risk preference, gain-loss preference, age, and gender, the regression result is still consistent with Hypothesis 2: although standard vagueness steadily increases from SD001 to SD500, compared to SD001 only the low level of variability of the choice threshold in SD100 has a significant negative effect on participants' slider choice.

> **Result 2 (overcompliance early):** After controlling for risk attitude, loss aversion, and gender, only SD100 has a significant negative effect on slider choices relative to SD001. The result signifies overcompliant choices in SD100.

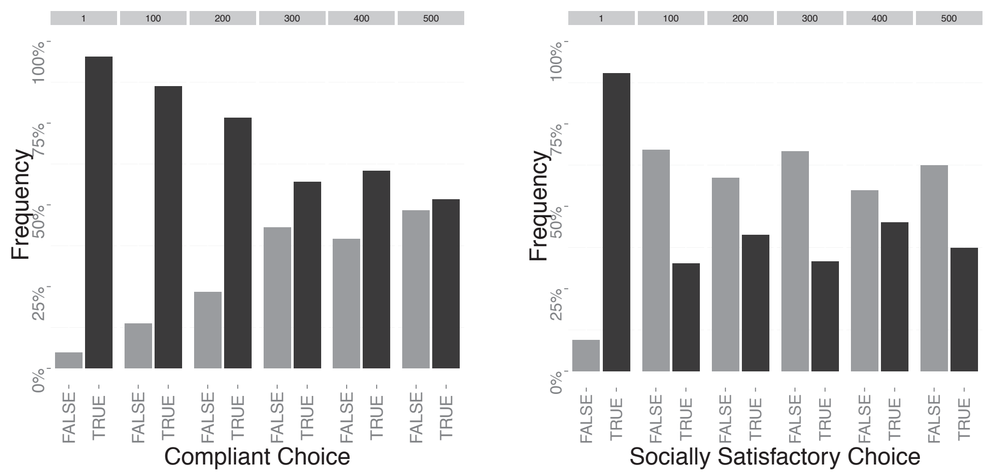
As an additional analysis, we assign observed slider choices to one of two categories. First, we define slider choices below or equal to the social optimality benchmark of 500 as "compliant" and the rest as "non-compliant". With this categorization we have socially optimal compliance in mind: according to our model, the regulator attempts to set a precise and efficient standard, which is always at an activity level of 500. We therefore do not define these categories in relation to the choice threshold drawn in each round and for each single choice because its distribution varied across treatments and, therefore, the meaning of "compliant" would strongly differ between treatments. We present results

[12] Note that we could only introduce the controls (model 2 in Table 3.4) for a subset of the data. In sessions 1 and 4 of the experiment, right after the main task, we experienced technical problems with the computer infrastructure of the laboratory. Therefore, we could not elicit risk preferences and gain-loss preferences of the 35 participants in these sessions. We ran both estimations on the same subset of the data to increase comparability between the models.

in this manner to illustrate the regulator's success at achieving compliance with the efficient standard, an evaluation of the results from the regulator's perspective.

The left panel of Figure 3.4 illustrates the share of compliant and non-compliant choices across treatments. In SD001 the vast majority of choices were compliant (95.24%) and only a small fraction of activity level choices were non-compliant (4.76%). With the exception of SD300 and SD400, Figure 3.4 shows a steady decrease of the proportion of compliant choices. Simultaneously, the proportion of non-compliant choices increases from SD001 to SD300 and from SD400 to SD500. In SD500, only 51.67% of participants' slider choices were compliant and 48.33% of choices were non-compliant. As the shares of compliant and non-compliant choices appear to level out at SD300, we conduct a Fisher's exact test and we reject the null that the proportions of compliant choices are equal between SD001 and SD300 (odds ratio = 0.0667, $p < 0.001$). At the same time, we do not reject the null that the proportions of compliant choices are equal between SD300 and SD500 (Fisher's exact test: odds ratio = 0.809, $p = 0.457$).

Figure 3.4 Proportions of compliant and socially satisfactory choices



To analyze these findings in more detail, we estimate treatment effects on compliant choices with a probit model. As before, we include SD100 to SD500 as dummy variables relative to SD001. Risk attitude, loss aversion, age and gender serve as control variables and we cluster standard errors on the participant level. From the control variables, only our risk attitude measure has a significant and slightly positive effect on the probability of a compliant choice. All treatment variables have a significant negative effect. As probit coefficients are difficult to interpret, Table 3.4 reports average marginal effects (AMEs) calculated from the probit estimation. Average marginal effects range from −29.49% in SD100 to −54.77% in SD500. After conducting an overall Wald test ($\chi^2 = 23.277$, $p < 0.001$), we reject the null that the estimated coefficients of the probit model are equal across treatments. Specifically, the estimated negative effect is significantly stronger in SD300 compared to SD200 (Wald test: $\chi^2 = 9.666$, $p = 0.002$). In fact, all pairwise comparisons that include the step from SD200 to SD300 are also significant on the 1%-level, while the estimated coefficients of SD300, SD400, and SD500 are statistically indistinguishable. Therefore we conclude that SD300, SD400, and SD500 have significantly stronger negative effects than SD100 and SD200 on the probability that a participant makes a compliant choice.

Result 3 (compliance crowding-out): Relative to SD001 participants in all treatments are less likely to be compliant. This effect is significantly stronger in SD300, SD400, and SD500 than in SD100 and SD200.

Second, we want to better understand the social impact of standard vagueness. To this end, we want to distinguish between those slider positions that approximate welfare maximisation and those that do not. Given the model parametrization, a precise and efficient choice threshold would be set at 500. Under these circumstances, a slider position of 500 would also be the individually optimal choice. To allow for some noise around the 500 benchmark, we use the standard deviation from observed slider choices in our quasi-legal-certainty treatment SD001 ($\sigma_{\text{SD001}} = 49.62$). Across all treatments we then define those slider choices as "socially satisfactory" that lie within σ_{SD001} around 500. Slider choices with a larger absolute difference to 500 are "socially unsatisfactory". We use this measure because SD001 resembles the control group of quasi-legal-certainty and the choices in SD001 are our best empirical benchmark for choice randomness absent choice threshold variability. Thus standard deviation of the choices in SD001 resembles the most narrow, yet least arbitrary criterion for our definition.

The right panel in Figure 3.4 reveals that the majority of choices in SD001 were socially satisfactory (90.48%), whereas only a small part was not (9.52%).

By contrast, already in SD100 choices exhibit a drastic reversal: the share of socially satisfactory choices is much lower (32.74%) than the share of socially unsatisfactory choices (67.26%). We reject the null that the proportion of socially satisfactory versus socially unsatisfactory choices is equal between SD001 and SD100 (Fisher's exact test: odds ratio = 0.052, $p < 0.001$). Finally, only 37.50% of slider choices remain socially satisfactory in SD500 whereas 62.50% were not. We conduct a Fisher's exact test and reject the null that the proportion of socially satisfactory versus socially unsatisfactory choices are equal between SD001 and SD500 (odds ratio = 0.064, $p < 0.001$). However, a rejection is not possible when comparing the proportion of choices between SD100 and SD500 (Fisher's exact test: odds ratio = 0.812, $p = 0.452$). The evidence indicates that the proportion of socially satisfactory and unsatisfactory choices switches as soon as the variability of the choice threshold exceeds a quasi-certain level.

To further analyze this finding, we estimate effects on socially satisfactory choice with a probit model, using the same model specifications as the previous probit model for compliant choices. Similar to the estimation for compliant choices, among the control variables only our risk attitude measure has a significant and negative effect on the probability of a socially desirable slider choice. Compared to SD001, all treatments have a significant negative effect. Table 3.4 reports average marginal effects (AMEs) calculated from the probit estimation. Again similar to the previous estimation, all treatment variables have a significant negative average marginal effect, starting at −36.45% in SD400 and increasing up to −43.86% in SD300. In contrast to the analysis of compliant choices, however, we cannot reject the null that the negative treatment effect is equal across treatments (Wald test: $\chi^2 = 2.165$, $p = 0.705$). This result suggests that introducing variability of the choice threshold has a strong and significant negative effect on the probability that a slider choice is socially satisfactory, irrespective of how pronounced is the variability. We conclude that, given any degree of standard vagueness beyond quasi-certainty, persons find it difficult to identify a socially satisfactory choice. We interpret this finding as loss of the coordination function of the standard. This means that the tortfeasor and the injured party no longer coordinate on taking precaution through a legal standard, instead either party is now likely to take precaution (the tortfeasor by reducing his activity level, the injured party by purchasing insurance), or to rely on the other party to do so. The result is both inefficient overprecaution/overinsurance and uncovered harm.

Table 3.4: Summary of regression analysis

	Slider choice		"compliant" choice	"socially satisfactory" choice
	Model 1	Model 2	(Probit AMEs)	(Probit AMEs)
SD100	−90.569**	−77.513**	−0.295***	−0.404***
	(39.414)	(39.937)	(0.104)	(0.049)
SD200	−32.092	−23.502	−0.352***	−0.384***
	(41.337)	(41.629)	(0.088)	(0.051)
SD300	2.215	−2.220	−0.516***	−0.439***
	(34.133)	(33.855)	(0.057)	(0.048)
SD400	18.625	13.175	−0.493***	−0.365***
	(34.133)	(33.336)	(0.063)	(0.050)
SD500	54.775	40.497	−0.548***	−0.416***
	(35.253)	(34.859)	(0.068)	(0.045)
Risk Attitude		−19.414***	0.051***	−0.056
		(6.372)	(0.019)	(0.021)
Loss Aversion		−0.030	0.001	0.000
		(0.302)	(0.001)	(0.001)
Age		0.056	−0.003	−0.005
		(2.571)	(0.008)	(0.007)
Female		15.906	−0.088	0.033
		(19.383)	(0.060)	(0.059)
(Intercept)	485.542***	609.659***		
	(27.870)	(83.146)		

*: $p < 0.10$; **: $p < 0.05$; ***: $p < 0.01$.

Result 4 (loss of coordination function): All treatments except SD001 (quasi legal certainty) have a strong negative effect on the probability that a participant chooses a socially satisfactory slider position. This effect does not differ between these treatments.

3.5 Discussion

The research in this chapter provides laboratory evidence for the effect of standard vagueness on activity level choices. We use standard vagueness as but one variation of legal uncertainty. In general, the observations refute the explicit and implicit notion in doctrinal legal scholarship that legal uncertainty should be minimized where possible due to its stifling of socially beneficial activities (cf.: Trubek, 1972; D'Amato, 1983; Popelier, 2000; Maxeiner, 2007, 2008; Smits, 2012). Although we could capture the legal intuition in a framework of reference-dependent preferences, the results do not match that legal intuition. However, the results clearly show that our participants were sensitive to the general presence and manipulation of standard vagueness. These results rather support earlier modelling efforts from the economic theory of law (Craswell and Calfee, 1986), as well as the notion that increases in legal uncertainty may necessarily not be socially disadvantageous.

The experimental evidence shows that a meaningful dynamic exists between activity choices and the degree of standard vagueness. The experiment does not reveal a monotonic negative relationship between standard vagueness and average slider choices, however. Rather, participants in this study responded non-monotonically to increases in standard vagueness. As a result, average slider choices exhibit a U-shape (Result 1). Participants were not only sensitive to the general presence of standard vagueness, but they differentiated between different vagueness levels and adopted non-monotonic responses. This finding suggests that intentionally reducing standard vagueness can result in unintended adverse consequences and undermine activity choices even further when standard vagueness is already high. Being concerned about different degrees of legal uncertainty—in contrast to treating a fixed level of legal uncertainty as a working hypothesis—is, therefore, relevant for finding appropriate legal solutions. To the detriment of individuals and society, different degrees of legal uncertainty can lead to adverse choices of rule-subjected persons.

Moreover, participants did not consistently choose inefficiently low slider positions. Only initial levels of standard vagueness (SD001, SD100, and SD200) induced significant overcompliant behaviour (Result 2). Whereas one may expect low standard vagueness to only cause insignificant overcompliance, overcompliance was much more pronounced at low standard variability than at high standard variability. Activity choices dropped quickly when the random choice threshold became less predictable. Interestingly, however, statistically meaningful overcompliant behaviour vanished already by SD300.

Altogether our results correspond to previous contributions suggesting that increasing legal uncertainty can have beneficial effects (Craswell and Calfee, 1986; Lang, 2014). Thus, the experimental evidence from our study suggests that the doctrinal view is warranted only when a rule designer confronts a choice between very low levels of legal uncertainty where activity choices on average erode with increasing legal uncertainty. Adopting a lower degree of legal uncertainty when legal uncertainty is already substantial may increase overcompliance. Conversely, increasing standard vagueness may lead to a socially desirable change in terms of average activity choices. If reducing legal uncertainty is costly, these counter-intuitive implications attain even more weight.

In addition, the experimental evidence reveals effects that have previously received little attention. First, the analysis shows that increasing legal uncertainty gradually decreases the proportions of compliant choices (Result 3). Under legal uncertainty, compliance is crowded-out. Second, the main share of participants' choices is not socially satisfactory as soon as more than minimal levels of legal uncertainty are induced in the experiment (Result 4). This result suggests that another hidden cost of legal uncertainty manifests in increasingly erratic behaviour: the rule loses its coordination function. To the best of our knowledge the discussion on legal uncertainty has not focused on this aspect, let alone backed-up such discussion by empirical results. The erosion of the coordination function of the law is an important finding because it affects the cost to society in anticipation of a certain individual activity choice. Such costs include the excessive or insufficient purchase of insurance and other investments to forego harm. Although the direct results of the experiment refute much of the legal intuition on legal uncertainty, both the crowding-out of compliant choices and the undermining of socially satisfactory choices reinvigorates the motivation to minimize legal uncertainty where possible. While the data suggest that an incremental reduction of standard vagueness from higher to lower levels facilitates compliant choices, stimulating socially satisfactory choices would require reducing standard vagueness to quasi legal certainty. This, however, is a tall order.

3.6 Conclusion

Legal scholars and economists disagree about the effects of legal uncertainty on a person's activity choice. Legal scholars argue that introducing or increasing legal uncertainty erode socially beneficial activities, whereas economists, counter-intuitively, propose that doing so may have beneficial effects under specific circumstances. We show that a model of activity choice under a vague legal standard can accommodate both views depending on the assumptions about a person's preference structure.

Our laboratory experiment studies how different degrees of standard vagueness impact activity choice by varying the dispersion of the distribution underlying the vague standard. The data from our experiment show that initial degrees of standard vagueness reduce average activity choices below the socially optimal level. After a sufficient increase of standard vagueness, however, participants' choices become less overcompliant. After a further increase, overcompliance vanishes. The data further reveal that both the share of noncompliant choices and the share of socially undesirable choices substantially increase with increasing degrees of standard vagueness. With increasing vagueness the standard loses its coordination function.

To the extent that our results apply to real-world settings, they have important policy implications. Whereas legal scholars often conceive of legal uncertainty as impairment of activity choice, our results suggest that, on average, reducing legal uncertainty may cause more harm than good. On the contrary, increasing legal uncertainty may sometimes be socially beneficial. We do not propose to design rules with a specific optimal degree of vagueness, however. We merely emphasize that the immediate urge to reduce, e.g., standard vagueness may be misguided, especially when such a policy generates substantial additional cost and when some amount of legal uncertainty is inherent in the law. Yet, whereas increasing legal uncertainty may on average not be socially detrimental, with increasing vagueness the law looses its coordination function. Therefore, our results draw attention to the need to shift the discussion about legal uncertainty from its average effects to the predictability of individual behaviour under different degrees of legal uncertainty and the consequences thereof. As our laboratory study implemented a vague legal standard, we refrain from drawing conclusions for forms of legal uncertainty different from standard vagueness.

Forms of legal uncertainty different from standard vagueness, however, are interesting avenues for further research. For example, legal uncertainty may concern outcomes such as compensatory or punitive damage awards. Moreover, changes in procedural or evidentiary rules may bias the distribution underlying the legal standard. Promising opportunities for future research also exist within our paradigm. Our contribution provides both a foundation and a benchmark to study, for example, the interaction of vague standards with social preferences. Tortious actions can happen in different social contexts:

under vague standards, a car driver facing a potential traffic accident with a stranger may adjust his activity differently than a physician treating a long-term patient that she knows well. Another interesting extension of our study asks to what extent gain-loss framing effects interact with different degrees of standard vagueness. Finally, while we experimentally test legal uncertainty inherent in legal rules, some may conclude from our results that legal uncertainty may be employed as policy tool. There is however reason to assume that individuals might derive a specific disutility from uncertainty in the justice system which we have not captured in the experiment.

3.7 Appendix

3.7.1 Robustness check with uniform distribution

As robustness check, we simulate the optimal responses $x_i^*(\sigma)$, $i \in \{\text{RN, RA, KR}\}$, when x_L is uniformly distributed around the socially optimal level x_S. To incorporate the notion of standard vagueness, we have defined $x_L \sim \mathcal{U}(x_S - 1.25\,\sigma, x_S + 1.25\,\sigma)$. Figure 3.5 depicts the results. The emerging pattern is comparable to the pattern under a normal distribution. Therefore our predictions don't change qualitatively under a uniformly distributed standard.

3.7.2 Difference to Calfee and Craswell, 1986

Craswell and Calfee (1986) propose in their Appendix A that a person maximizes $U_{CC}\big(x\big) = u\big(b(x)\big) - F(x)\,u\big(e(x)\big)$, where $u'(\cdot) > 0$, $u''(\cdot) < 0$ (Craswell and Calfee, 1986, p. 300). Reverse-engineering an expected utility expression with a complete probability space from the latter maximization problem yields

$$\begin{aligned} U_{CC}\big(x\big) &= u\big(b(x)\big) - F(x)\,u\big(e(x)\big) \\ &= \big(1 - F(x)\big)\,u\big(b(x)\big) + F(x)\,u\big(b(x)\big) - F(x)\,u\big(e(x)\big) \\ &= \big(1 - F(x)\big)\,u\big(b(x)\big) + F(x)\,\Big(u\big(b(x)\big) - u\big(e(x)\big)\Big). \end{aligned} \tag{3.10}$$

Hence, the underlying utility function of Craswell and Calfee (1986)'s risk-averse agent is

$$u_{CC}\big(x\big) = \begin{cases} u\big(b(x)\big) & \text{for } x \leqslant x_L \text{ (compliance)} \\ u\big(b(x)\big) - u\big(e(x)\big) & \text{for } x > x_L \text{ (violation)} \end{cases} .$$

The crucial difference between the utility functions $u_{RA}(\cdot)$ in expression (**??**) and $u_{CC}(\cdot)$ lies in how a person evaluates outcomes of choices that are potentially violating the legal standard ($x > x_L$). Under $u_{RA}(\cdot)$ a person first computes final wealth and then evaluates this outcome through his utility function (asset integration), i.e., $u\big(b(x) - e(x)\big)$ for $x > x_L$. Conversely, under $u_{CC}(\cdot)$ a person separates these different payoff streams and in an isolated way computes the utility for each of the payoffs (asset isolation), i.e., $u\big(b(x)\big) - u\big(e(x)\big)$ for $x > x_L$. This difference concerns a crucial assumption about how a person edits or codes lottery outcomes (Kahneman and Tversky, 1979; Thaler, 1985; Read, Loewenstein, and Rabin, 1999). The hedonic consequences of the decision then depend on which editing procedure is used (cf.: Wakker, 2010, p. 235-236).

The assumption of asset isolation implicitly found its way into Craswell and Calfee (1986)'s analysis and has consequences for choice predictions under vague standards. Differentiating expression (3.10) with respect to x and evaluating the result at the socially optimal level x_S, where $b'(x) = e'(x)$, yields

$$\frac{\partial U_{CC}\big(x\big)}{\partial x}\Big|_{x_S} = \big[1 - F(x_S)\,\frac{u'\big(e(x_S)\big)}{u'\big(b(x_S)\big)}\big]\, u'\big(b(x_S)\big)\, b'(x_S) - F'(x_S)\, u\big(e(x_S)\big). \tag{3.11}$$

Note that the marginal benefits of increasing x are not only discounted by the probability $1-F(x_S)$ as in the main text, but rather by $1-F(x_S)\, u'\big(e(x_S)\big)/u'\big(b(x_S)\big)$. Because we evaluate the decision locally at x_S, we reformulate the additional factor $u'\big(e(x_S)\big)/u'\big(b(x_S)\big)$ to

$$\frac{u'\big(e(x_S)\big)}{u'\big(b(x_S)\big)} = \frac{u'\big(e(x_S)\big)}{u'\big(b(x_S)\big)}\,\frac{b'(x_S)}{b'(x_S)} = \frac{u'\big(e(x_S)\big)}{u'\big(b(x_S)\big)}\,\frac{e'(x_S)}{b'(x_S)} = \theta.$$

Parameter θ may be interpreted as marginal rate of substitution between $u\big(e(x)\big)$ and $u\big(b(x)\big)$, i.e., the local rate at which a person is willing to compensate for the negative externality of activity x in exchange for receiving the private benefits of said activity while maintaining the same level of total utility. If $\theta > 1$, then $1 - F(x_S)\ \theta < 1 - F(x_S)$. With risk aversion and asset isolation as in (3.11), marginal benefits of increasing x are discounted more than with risk aversion and asset integration in (**??**). Therefore, iff $\theta > 1$ the first term of expression (3.11) is smaller than the first term in expression (**??**). This case creates a stronger tendency to choose $x^* > x_S$ (undercompliance). By contrast, iff $\theta < 1$ then $1 - F(x_S)\ \theta > 1 - F(x_S)$, i.e., marginal utility of increasing x would be discounted less under asset isolation. Therefore, iff $\theta < 1$ the first term of expression (3.11) is larger than the first term in expression (**??**). This case creates a stronger tendency to choose $x^* < x_s$ (overcompliance). Altogether, a person who edits outcomes according to asset isolation is more likely to deviate from x_S when the legal standard is somewhat random.

To illustrate the contrast from assuming asset isolation in lieu of asset integration, we simulate the distinctive response function $x^*_{CC}(\sigma)$ (asset isolation) and compare it to $x^*_{RA}(\sigma)$ (asset integration) in Figure 3.6. Instead of a transition from overcompliance at lower degrees of vagueness to undercompliance at higher degrees of vagueness, $x^*_{CC}(\sigma)$ exhibits a rapid drop over the entire range of σ so that $x^*_{CC}(\sigma) < x^*_{RA}(\sigma)$. This pattern signifies extensive overcompliance. That is, assuming asset isolation combined with risk aversion supports the legal scholarship view on legal uncertainty.

3.7.3 Parameter specification

For the generation of the hypotheses, for the simulation of the different response functions, and for the payoff structure in the experiment, the following specifications for $b(x)$ and $e(x)$ hold:

$$\begin{aligned} b(x) &= 50\, ln(x) \\ e(x) &= 0.1\, x \end{aligned}$$

These specifications come from Craswell and Calfee (1986)'s first example (Craswell and Calfee, 1986, p. 284).

We use a utility function with constant relative risk aversion (CRRA); specifically, a utility function from the power family $u(w) = w^r$. Utility functions of this form are widely used for modelling risk aversion in economics

Figure 3.5 Over- and undercompliance with uniformly distributed x_L

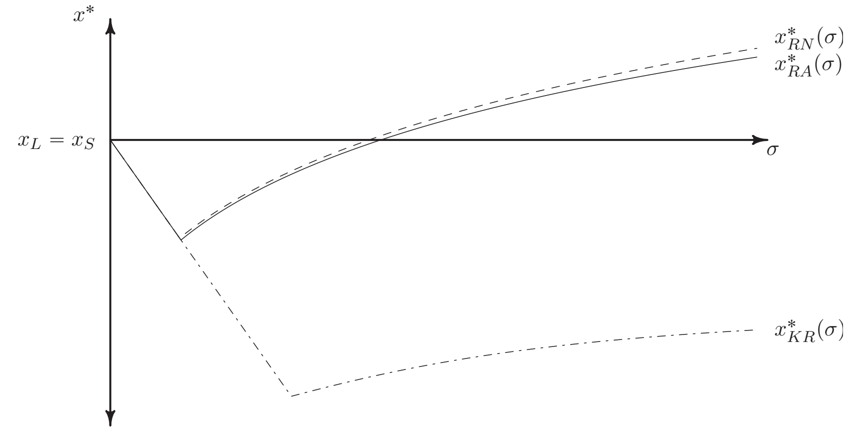
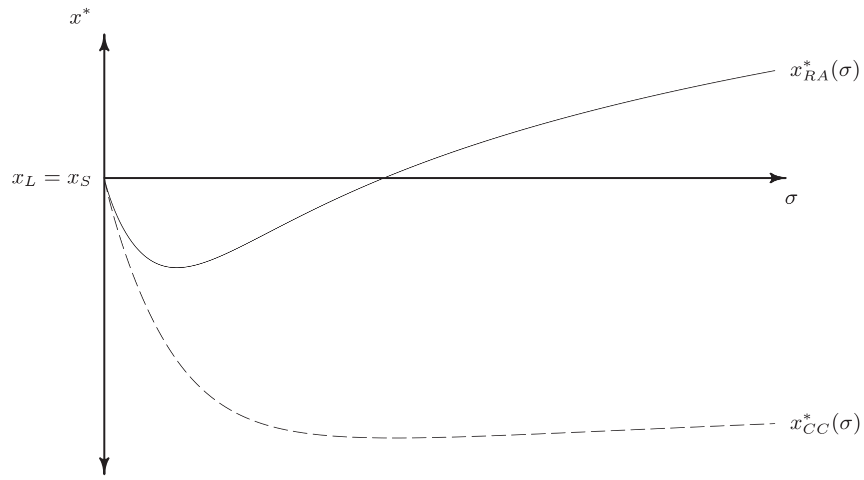


Figure 3.6 Asset Integration vs. Asset Integration



and psychology and often fit empirical results better than alternative functional forms (Wakker, 2008). We parametrized the curvature parameter with $r = 0.48$ in accordance with the recent estimate of Gneezy, Imas, and List (2015). We prefer the estimate from this elicitation mechanism because risk attitude is domain specific and Gneezy, Imas, and List (2015)'s elicitation is based on lottery choices similar to our experiment.

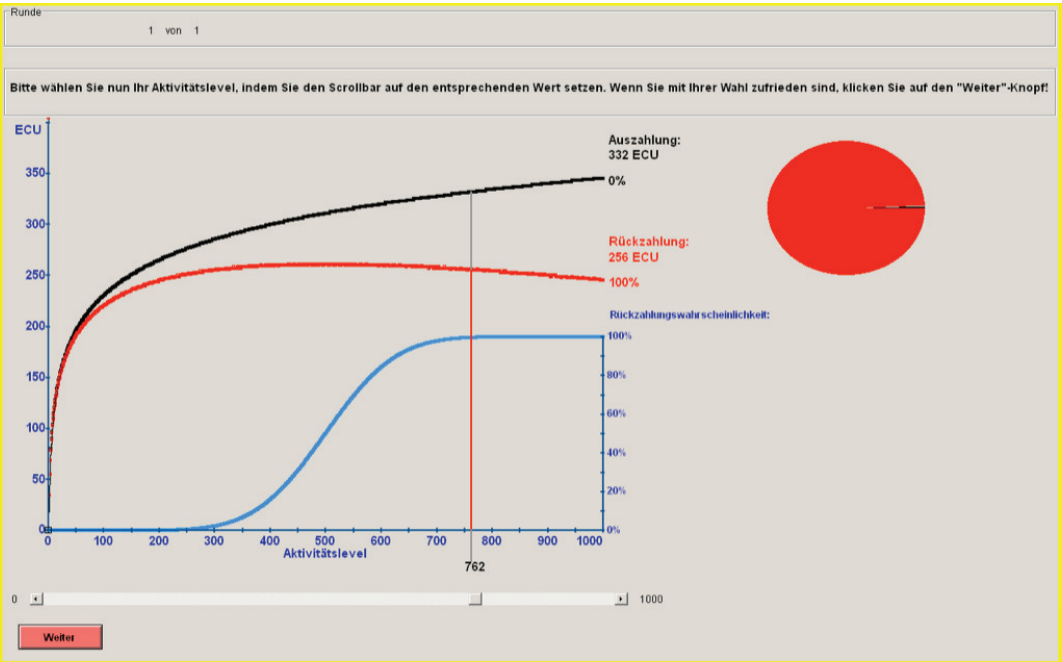
We parametrize loss aversion with $\lambda = 2.61$ in acoordance with the estimation of Abdellaoui, Bleichrodt, and L'Haridon (2008, p. 258). Their elicitation method strikes a balance between non-parametric measurements and susceptibility to response error and provides an advantage in measurement efficiency. Moreover, the elicitation mechanism only uses those parametric assumptions that are widely supported in the literature, i.e., the power specification for utility that we also used to model the curvature of the utility functions. The method is also perceived to be easier than other methods and minimizes cognitive burden for participants which leads to high reliability. Finally, the method is robust because elicited measurements do not depend on specific probability values. In this regard, the measurements are unconfounded. Abdellaoui, Bleichrodt, and L'Haridon (2008) also found no gender effect in the estimation of loss aversion with their procedure.

Note that we did not find a fundamental change in the prediction pattern from the simulations depicted in Figure 3.1, even when altering the parametrization.

3.7.4 Additional experimental description

The following figure contains a decision screen in treatment SD100. The screen shows the payoff function $b(x)$ for the chosen activity level, the reduced payoff function $b(x) - e(x)$, and a cumulative distribution function that determines the probability of exceeding the randomly determined activity benchmark. On this screen, the slider position is set to 762. The screen depicts potential payoffs in ECU with their corresponding probabilities for this slider position. Because people are commonly found to struggle with the meaning of specific probabilities, the pie chart next to the payoffs displays the meaning of the probabilities.

Figure 3.7 Sample Screen of the Decision Screen in the Experiment



Chapter 4

Better Safe than Sorry: Can Social Preferences Mitigate Defensive Behaviour under Vague Standards?

Abstract: In Chapter 3 we have investigated behavior when legal standards are uncertain, based on a theoretical model by Calfee and Craswell (1986). In this chapter I expand the model and the experimental set-up to allow for an effect of social preferences. I test the robustness of Chapter 3's results to then focus on the effect of legal standard vagueness when social proximity between a tortfeasor and an injured party is relatively close. I want to show whether pro-social preferences mitigate defensive behaviour. The data replicate the presence of overcompliance, without the U-shaped relationship between activity choices and standard vagueness. Behavior is not adjusted upon the introduction of a second player whose profit is affected by the activity. The results cast doubt on the original predictions and on the experimental results from Chapter 3. Instead defensive behavior seems to occur at any level of standard vagueness. Pro-social preferences seem to mitigate defensive behavior, but loose their predictive power at high levels of standard vagueness.

Keywords: legal vagueness; social preferences; experimental law and economics

4.1 Introduction

The discomfort with the prevalence of legal indeterminacy and legal uncertainty has been addressed regularly during the past two centuries by scholars in the field of legal philosophy. In 1823, Jeremy Bentham expressed his dislike for the unpredictability of the common law, which he largely associated with the fact that law was created ex-post, rather than provided to society ex-ante (Bentham, 1823, ch. XVII, sec. 83). Bentham considered this feature of uncodified law as a major forgone opportunity for the lawmaker: in sanctioning ex post, the lawmaker cannot use the law to provide a behavioural framework to steer society as a whole.[1] The realisation that codification also fails to eradicate uncertainty is discussed just as comprehensively by scholars of civil law. The most passionate illustration is provided by Von Jhering, referring to his dream of the heaven for legal theoreticians. In this dream he envisioned finally seeing the entirety of vague concepts of jurisprudence present themselves to him in perfect clarity (Von Jhering, 1884).

Codification cannot dispose of that share of legal uncertainty that originates from the use of imprecise legal concepts, such as due, reasonable, contract, conspiracy, malice or proximate cause, which can all be manipulated in a variety of acceptable ways (Cohen, 1935). Indeterminacy of codified law prevails because the complete clarification of vague concepts would require their meticulous definition for each possible situation. The cost of generating and handling such a comprehensive code would be prohibitive. Furthermore, greater specificity of a code is also associated with a high likelihood for internal inconsistencies (D'Amato, 1983). Given that uncertainty over legal obligations prevails, irrespective of the underlying legal system, its effect on behaviour and the extent to which it can be guided should be investigated.

The effect of probabilistic enforcement on compliance with the law was initially formalised by Becker (1968) in the context of the deterrence of criminal behaviour. According to his deterrence hypothesis, crime rates decline in increases in the probability of punishment, as the expected cost to some criminals of punishment outweighs the expected benefit of the criminal activity.[2]

[1] Bentham goes so far as to compare the development of the common law to the way a dog is taught to behave: "When your dog does anything you want to break him of, you wait till he does it, and then beat him for it. This is the way you make laws for your dog and this is the way judges made law for you and me." (Works V 235)

[2] The deterrence hypothesis states that criminal behaviour declines both in the probability of punishment, as well as in the magnitude of the fine.

Outside of criminal law, legal standard vagueness brings about a similar trade-off as probabilistic criminal enforcement (Sunstein, 1995): The probability of being held liable at a given level of undercompliance decreases in increases of legal standard vagueness. Hence, increases in standard vagueness reduce the expected cost of liability at any level of undercompliance, and make undercompliance relatively more attractive to the agent. As compared to the criminal scenario, there exists a further dimension in which the agent's behaviour can diverge from the optimum under a vague legal standard, namely by making overcompliant or defensive choices. Even at high levels of precaution, agents face a positive probability of being held liable, which they can reduce by increasing their compliance efforts even further. As a result, legal standard vagueness might actually stifle behaviour that the law-maker seeks to encourage (D'Amato, 1983).

The contributions of Calfee and Craswell (1984) and Craswell and Calfee (1986) formalise these two opposing effects of uncertainty over legal standards on actors' efforts to comply with the law. In a pure expected-value framework, Craswell and Calfee (1986) conclude that relatively low levels of uncertainty cause actors to overcomply with the standard, while relatively high levels of standard vagueness will induce undercompliance.

In the previous chapter we expanded the model of Craswell and Calfee (1986) to incorporate various behavioural paradigms, and use a laboratory experiment to test the predictions. The results confirm the predictions from the original paper, reject the influence of prospect theory, point out the importance of individual risk preferences, and suggest that both overcompliance and undercompliance can be consequences of legal uncertainty. Furthermore, the findings suggest that increasing legal standard vagueness might actually decrease the deviation from the lawmaker's desired behaviour, and therefore increase social efficiency. There is even evidence that, at least in theory, there exists a level of standard vagueness that induces compliance and which can therefore serve as a second-best alternative to legal certainty. This notion of positive effects from legal uncertainty is also in line with the theoretical findings of Lang (2014) and a more general reconsideration of the issue outside of traditional legal scholarship.

This chapter complements Chapter 3 by allowing for the presence of social preferences in the actor's utility function. This is relevant from a theoretical point of view, as it reverses the original model's predictions in terms of over- and undercompliance. With regard to the application of the results, social preferences likely play a role in all circumstances in which decision making agents are aware of the externality they might produce, and particularly when they can also identify the party who will bear the cost of the externality. Principal-agent relationships, such as the physician-patient relationship can serve as practical examples in which defensive behaviour is particularly frequent and well documented.

The scope of defensive behaviour in the medical sector is illustrated by Studdert et al. (2005). The authors find that 93% of the responding physicians admit to the practise of defensive medicine, indicating that they deviate from optimal behaviour to reduce their probability of liability. Thirty-nine percent of the specialist physicians have decided to restrict treatment in cases with high risk of liability, a practise that is known as 'negative defensive medicine'. Fifty-nine percent of the surveyed physicians admitted to being overcautious, or engaging in so-called 'positive defensive medicine'. This proportion was significantly higher amongst specialist practitioners. A more recent study by Bishop, Federman, and Keyhani (2010) confirms this finding. The authors determine that 91% of physicians in the US believe that malpractice pressure leads to an increase in the number of ordered diagnostic tests and procedures beyond the necessary amount. Hence, insight into the effect of vague standards holds the potential for vast savings from reducing the cost from overcompliance.

In this chapter I focus on three main behavioural theories that would explain a divergence in results from the findings in Chapter 3. All three are used to explain distributional choices in one-shot games.

A first theory explains individuals' choices by their preference for equitable outcomes, following the formalisation of Fehr and Schmidt (1999). Inequity aversion claims that individuals experience disutility from either receiving a higher payoff or a lower payoff than their peers. Secondly, I will incorporate a preference for social efficiency into the model. Experimental evidence shows that subjects in binary-choice dictator games were more willing to make efficiency promoting choices than equity oriented ones, even if this reduced the individual's own payoff (Bolle and Kritikos, 2001). Furthermore, Andreoni and Miller (2002), Charness and Rabin (2002) and Engelmann and Strobel (2004) show that the giving behaviour of a non-negligible fraction of participants, in a range of games, can be explained with a preference for socially efficient outcome. As a third theory I will consider that decision making agents attach weight to the outcome of the least well-off individual in a given society. These Rawlsian or maximin preferences have contributed to the explanation of the results of several laboratory experiments (Andreoni and Miller, 2002; Charness and Rabin, 2002; Engelmann and Strobel, 2004).

In the following Section 4.2, I will briefly introduce the initial theoretical model as in Chapter 3, which is based on the work of Craswell and Calfee (1986). Subsequently, I will incorporate the behavioural theories mentioned above, and derive hypotheses for the behaviour of the decision maker. The experimental set-up will be described in Section 4.3. I will provide the experimental results in Section 4.4, and discuss their implications in Section 4.5. In Section 4.6, I offer concluding remarks.

4.2 Theory & Predictions

Similarly to the approach in Chapter 3, I derive predictions based on Calfee and Craswell's (1986) theoretical model, in which a rational and self-interested agent chooses a particular activity level x with $x \in [0, \bar{x}]$, wehere $\bar{x}$ is the upper boundary of the activity level x. The agent's profit from engaging in activity x are described $b(x)$, which is assumed to be concave, i.e. $b'(x) > 0$, $b''(x) \leqslant 0$.

As in Chapter 3, engaging in activity x generates a negative externality $e(x)$, which now presents a real cost to another person. I assume that the externality function $e(x)$ is twice differentiable and convex, i.e., $e'(x) > 0$, $e''(x) \geqslant 0$.

The socially optimal activity level, x_s, maximises the difference between the benefit from activity x and the cost from the externality. Hence, optimality is achieved when the condition $b'(x) = e'(x)$ is met, when the marginal benefit from activity x yields the marginal cost. A social planner will seek to discourage overcompliance, choices where $x > x_s$ and undercompliance, where $x < x_s$, by enforcing reimbursement for the externality at high activity levels and abstaining from doing so at low activity levels.

This requires the introduction of a legal standard X_l, with $0 < X_l < \bar{x}$, to regulate activity x. The standard represents the maximum quantity of activity x that is tolerated in the particular society. As long as an agent chooses an activity level below or equal to this legal standard, $x \leqslant X_l < \bar{x}$, she is considered compliant and will not face legal consequences. Inversely, an agent who chooses $X_l < x \leqslant \bar{x}$, violates the legal standard and has to perfectly compensate the other person for the costs of the externality.

In line with Chapter 3, I assume that the legal standard is not fixed, but rather that it is normally distributed around the optimal level, x_s, i.e., $X_l \sim \mathcal{N}(x_s, \sigma)$.[3] When the agent selects her activity level, she only knows that with increasing x, there is an increasing probability $P(x > X_l) = \Phi(x)$ with $\phi(x) > 0$ that she will be found in violation with X_l and will therefore be held liable. Conversely, $P(x \leqslant X_l) = 1 - \Phi(x)$ represents the (counter-)probability that the agent is found compliant with X_l.

The assumption of the stochastic nature of X_l is intended to reflect real world scenarios, such as the differing interpretation of vague legal standards, the ex-post determination of standards of care or generally imperfect knowledge about the law by those who are subject to it.

The degree of standard vagueness is given by the standard deviation σ of $\Phi(x)$. A larger σ indicates a wider range of possible legal standards, X_l, around the distribution mean, x_s.

4.2.1 Standard preferences

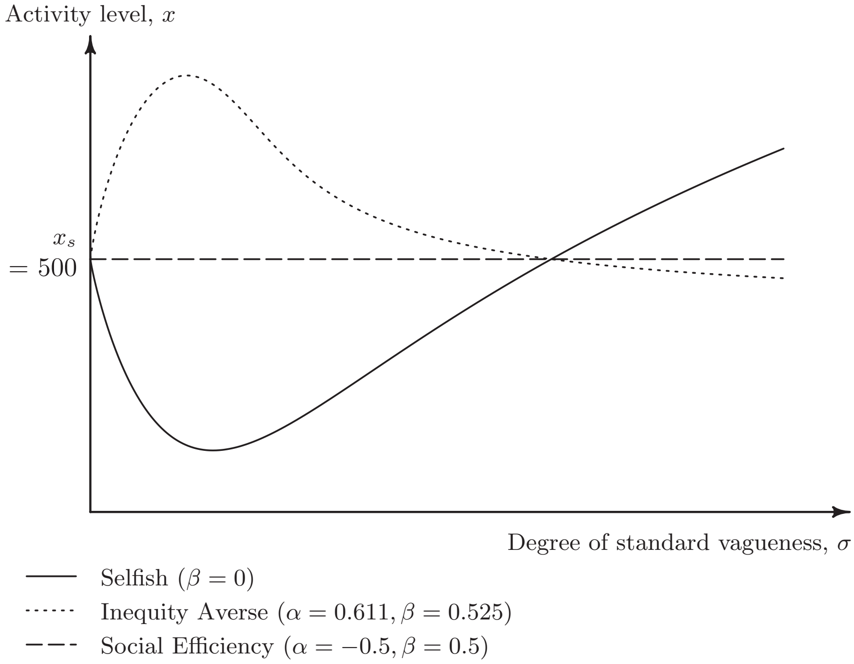
In this section I briefly describe behavior under standard preferences, a detailed derivation can be found in Section 3.2.1 in the previous chapter.

Figure 4.1 depicts the relationship between standard vagueness and the chosen activity level.[4] The vertical axis of the graph in Figure 4.1 measures the activity level and depicts the individually optimal choice x^* relative to the socially optimal level x_s. The horizontal axis in the graph measures the standard deviation, σ, of the distribution of the legal standard. The solid line in Figure 4.1 represents the response function $x^*_{\mathrm{S}}(\sigma)$ under standard preferences: if $\mu = x_s = X_l$, a sufficiently low level of standard vagueness is associated with overcompliance until a tipping point is reached. Beyond this tipping point, any further increases in σ lead to a reduction of overcompliance and, eventually to undercompliance. As identified in Chapter 3, the shape of the response function allows two main conclusions. First, reductions in the standard vagueness do not always lead to more socially efficient choices. Depending on the initial

[3] As a robustness check, we depict predictions in Chapter 3 for the case where X_l is uniformly distributed in the Appendix A to their paper.

[4] The numerical approximations of all relations $x^*_i(\sigma)$ with $i \in \{\mathrm{S, IE, SE}\}$ in Figure 4.1 have been constructed with the software environment R. A mathematical solution was not possible because $F(x)$ has no closed form representation.

Figure 4.1 Over- and undercompliance for different preference structures



level of uncertainty, vagueness reductions can actually increase the deviation from the optimum (i.e., the difference between x^* and $x_s = X_l$ may increase x_s).[5] Secondly, it must be pointed out that at least one further level of standard vagueness exists, aside from legal certainty, at which the selfish agent chooses the socially optimal activity level $x^*_S(\sigma) = x^*_S(0) = x_s$.

In the previous chapter we have tested this scenario in the lab and have collected evidence that confirms the predictions for selfish agents with standard preferences from Calfee and Craswell (1986). While the original paper and the model extension in Chapter 3 assume the presence of an affected party, neither approach takes payoff distribution preferences or cumulative payoff preferences

[5] A more extensive analysis within the risk neutral & selfish framework can be found in Craswell and Calfee (1986).

into account. I therefore develop alternative predictions for the chosen activity levels, which are based on different models of social preferences.

4.2.2 Social Preferences: Inequity Aversion

The distinctive difference between this chapter and the experimental research in Chapter 3 is that the chosen activity level creates a negative externality on another person. In Chapter 3 the probability and magnitude of a repayment increased in the activity level, but the chosen activity level only affected the decision makers own expected payoff. In the new design, the cost to another participant increases in the selected activity level. This forces the decision making agent to trade off the size of her own payoff against the size of another participant's payoff, allowing for social preferences to enter into the decision making process. The particular decision situation shares attributes with two well-researched situations:

On the one hand, this scenario resembles the dictator game (Kahneman, Knetsch, and Thaler, 1986). In the dictator game, one party (the dictator) determines how to divide a sum of money between herself and another person (the recipient). The choice of the activity level is analogous in that the decision maker's own profits and the 'recipient's' damages increase in the activity level. Hence, the 'dictator' allocates (positive and negative) payoffs to herself and the recipient.

The scenario also shares a crucial trait with the ultimatum game (Güth, Schmittberger, and Schwarze, 1982). In the ultimatum game, one party divides a sum of money between herself and a recipient, who then decides to accept or reject the offer of division. If the the offer is rejected, neither party receives any payoff. Proposers in the ultimatum game and the active party who chooses an activity level both face a vague behavioural standard. The proposers in the ultimatum game don't know whether a given offer will be accepted by the recipient, and the decision maker in the decision situation from Chapter 3 does not know with certainty whether the chosen activity level meets the vague standard. Yet, in both cases the decision makers know that they can influence the probability of meeting the standard by changing the generosity of their offer.

Experimental evidence shows that decision makers do not merely maximise their own payoffs in either situation. Instead fairness and efficiency concerns play a role. For the sake of making more accurate predictions, I will include these type of preferences into the decision making agent's utility function.

In the first reconsideration of the model I incorporate inequity aversion according to the description of Fehr and Schmidt (1999). Hence, I assume that the decision making agent is averse to payoff inequality resulting from her chosen level of activity, x. The decision making agent experiences disutility when another individual receives payoffs above an upper equitable benchmark (envy) and when that other individual receives payoffs below a lower equitable benchmark (compassion). There are multiple options for the selected equitable benchmark with which she compares the other's payoff. In line with Fehr and Schmidt (1999), I assume that a person will use her own final payoff as the relevant equitable benchmark to which she compares another person's payoff.[6]

Therefore, let an inequity averse person derive utility as described by the following utility function:

$$U_{IE}(m_i, m_j) = m_i - \alpha \max\big[m_j - m_i, 0\big] - \beta \max\big[m_i - m_j, 0\big]$$

where m_i describes the inequity averse agent's payoff, m_j describes the other's payoff, $\max\big[m_j - m_i, 0\big]$ reflects the disutility from envy that is weighted by parameter α, and $\max\big[m_i - m_j, 0\big]$ represents disutility from compassion that is weighted by parameter β. In line with Fehr and Schmidt (1999) let us assume $\alpha \geqslant \beta$ and $0 \leqslant \beta < 1$ for the case of inequity aversion. The first condition implies that a decision making agent has a larger disutility from receiving a dollar less than the other person, than from receiving a dollar more. The second condition implies that the agent experiences disutility from being better off than the other person, but not enough to dispose of her own payoff.

If a person is found compliant with X_l, her payoff is $m_i = b(x)$ and the other's payoff is $m_j = -e(x)$. Conversely, if a person is found to violate X_l, her payoff is $m_i = b(x) - e(x)$ due to payment of damages and the others payoff is $m_j = -e(x) + e(x) = 0$ due to perfect compensation. Therefore, I can specify an inequity averse person's utility who decides on x as follows:

[6] Note, that this is just one option. A person may alternatively care about, e.g., deviations from the status-quo or from the group's mean payoff.

$$
U_{IE}\big(b(x), e(x)\big) = \begin{cases} b(x) - \alpha \max\big[-e(x) - b(x), 0\big] & \\ -\beta \max\big[b(x) - \big(-e(x)\big), 0\big] & \text{if } x \leqslant X_l \\ & \text{(compliance)} \\ b(x) - e(x) - \alpha \max\big[0 - \big(b(x) - e(x)\big), 0\big] & \\ -\beta \max\big[b(x) - e(x) - 0, 0\big] & \text{if } x > X_l \\ & \text{(violation)} \end{cases} \tag{4.1}
$$

$$
= \begin{cases} b(x) - \beta\,\big[b(x) + e(x)\big] & \text{if } x \leqslant X_l \\ & \\ b(x) - e(x) - \alpha \max\big[-b(x) + e(x), 0\big] & \\ -\beta \max\big[b(x) - e(x), 0\big] & \text{if } x > X_l \end{cases} \tag{4.2}
$$

Note that if an agent is found compliant with X_l, since $b(x) \geqslant 0$ and $e(x) \leqslant 0$, there will never be envy, only compassion, as long as some level of activity x is carried out (i.e. $x \neq 0$). Conversely, if an agent is found noncompliant with X_l, there will only be envy if $b(x) < |e(x)|$ and the subsequent liability payment leaves the decision making agent worse off than the restituted counterpart. Compassion is only experienced if $b(x) > e(x)$. For clarity, we denote the envy term as $E(x) = \alpha \max\big[-b(x) + e(x), 0\big]$ and the compassion term as $C(x) = \beta \max\big[b(x) - e(x), 0\big]$.

An inequity averse agent who seeks to maximise expected utility therefore solves:

$$
\begin{aligned} &\max_x E\big[U_{IE}\big(b(x), e(x)\big)\big] \\ \Longleftrightarrow &\big(1 - \Phi(x)\big)\big[b(x) - \beta\,[b(x) + e(x)]\big] + \Phi(x)\big[b(x) - e(x) - E(x) - C(x)\big] \end{aligned} \tag{4.3}
$$

Differentiating $E\big[U_{IE}\big(b(x), e(x)\big)\big]$ with respect to x and evaluating this result at the social optimum x_{so} where $b'(x) = e'(x)$, we obtain:

$$\frac{\partial U_{IE}\big(b(x), e(x)\big)}{\partial x} = \big(1 - \Phi(x^*_{IE})\big)\,(1 - 2\,\beta)\,b'(x^*_{IE}) - \phi(x^*_{IE})\big(e(x^*_{IE}) - \beta\,[b(x^*_{IE}) + e(x^*_{IE})] + E(x^*_{IE}) + C(x^*_{IE})\big) \overset{!}{=} 0 \tag{4.4}$$

The dotted line in Figure 4.1 represents a numerical approximation of $x^*_{IE}(\sigma)$. I employ parameter values of $\alpha \approx 0.611$ and $\beta \approx 0.525$, which are the median values, found in a set of experiments by Blanco, Engelmann, and Normann (2011). For the chosen parameters, $x^*_{IE}(\sigma)$ generates prediction which oppose $x^*_S(\sigma)$: a sufficiently low level of σ induces undercompliance, while further increases of vagueness first reduce undercompliance and eventually induce overcompliance. However, the deviation from the social optimum is always smaller, as compared to the standard case. It can be noted that the standard choice pattern under selfish preferences can also be produced within this model, as long as the decision maker is indifferent to the other person's payoff being less than his own, $\beta \leqslant 0$.

4.2.3 Preferences for social efficiency

If I relax the imposed parameter restrictions with regard to α and β, the envy parameter α can take negative values. This signifies that the agent derives positive utility from the surplus payoff that another person has, compared to the agent. If the compassion parameter β remains positive, the decision making agent's preferences are concerned with the overall payoff in society, or efficiency. While inequity aversion is frequently discussed as the behavioural motivation to explain non-selfish behaviour in a variety of games, multiple experiments have shown that the model actually lacks explanatory power. Engelmann and Strobel (2004) test the relative performance of efficiency concerns, maximin preferences and inequality aversion against each other. The data points to a stronger influence of social efficiency and maximin concerns as compared to that of inequality aversion. In line with this finding, Andreoni and Miller (2002) estimate that about 22.4% of their sample exhibited some degree of preference for social efficiency and Bolle and Kritikos (2001) find a majority of efficiency-oriented participants in binary dictator games.

If individuals are perfectly efficiency minded, they prefer the maximisation of net social benefits and are indifferent which party bears the costs of the externality. For parameter values of $\alpha = -0.5$ and $\beta = 0.5$, the agent's preferences coincide with the the goal of the sophisticated lawmaker in the scenario at hand and the agent chooses an activity level of $x^*_{\text{SE}}(\sigma) = x_s = X_l$ which is depicted as the dashed line in Figure 4.1.

However, it is more common that individuals have somewhat weaker concerns for social efficiency. Milder efficiency concerns in the utility function will decrease, but not eliminate, the degree of overcompliance or undercompliance.

Indifference to the liability payment is specific to the specified scenario in which litigation is costless and punitive damages are excluded. Introducing litigation costs or punitive damages would reduce the chosen activity level, $x^*_{\text{SE}}(\sigma)$, at every level of legal standard vagueness, but would also alter the socially efficient activity level and the lawmaker's preference.

4.2.4 Social Preferences: maximising the minimum payoff

While inequity aversion has a certain explanatory power for the behaviour in ultimatum games and public goods games, it does not do as well in predicting allocations in dictator games (Andreoni and Miller, 2002).

As mentioned in the previous section, Andreoni and Miller (2002) find that behaviour differs according to types. Aside from the group that made decisions with social efficiency in mind, a further 47.2% of the sample behaved in a selfish manner. The remaining 30.4% preferred equal payoffs for the participants, implying maximin preferences.

I derive behavioural predictions, based on Rawls' maximin principle, by changing the assumptions over α and β in Equation (4.2). If $\alpha = 0$ and $\beta = 1$, a person derives positive utility from his own payoff but is indifferent to another person faring better than her. On the other hand, the person receives a unit-for unit reduction in her utility, from the difference between her own payoff and that of another person who receives less.

Changing the envy and compassion parameters in this way simplifies the utility function to the following:

$$U_{MM}(m_i, m_j) = \min[E(m_i), E(m_j)] \tag{4.5}$$

Which can be specified as:

$$U_{MM}\big(b(x), e(x)\big) = \begin{cases} \min\big[b(x), -e(x)\big] & \text{if } x \leqslant X_l \\ & \text{(compliance)} \\ \\ \min\big[b(x) - e(x), 0\big] & \text{if } x > X_l \\ & \text{(violation)} \end{cases} \tag{4.6}$$

$$= \begin{cases} -e(x) & \text{if } x \leqslant X_l \\ & \&\ x > 0 \\ 0 & \text{if } x \leqslant X_l \\ & \&\ x = 0 \\ 0 & \text{if } x > X_l \\ & \&\ b(x) \geqslant e(x) \\ b(x) - e(x) & \text{if } x > X_l \\ & \&\ b(x) < e(x) \end{cases} \tag{4.7}$$

Therefore the agent maximises the following function:

$$\max_x E\big[U_{MM}\big(b(x), e(x)\big)\big] \iff (1 - \Phi(x)) \min[b(x)\,,\, -e(x)] + \Phi(x) \min[b(x) - e(x)\,,\, 0] \tag{4.8}$$

In the case at hand, the person who bears the cost of the externality is worse-off. There exist two ways in which the agent can maximise her payoff: either by choosing not to engage in the activity at all, $x^*_{\text{MM}}(\sigma) = 0$, or by increasing the activity level to the point at which the repayment is certain, $\Phi(x) = 1$. The maximin-seeking agent will do the latter, as long as the the benefit from the undertaking the activity at this level, $x_{\Phi=1}$, is still larger than the cost from the liability payment, $b(x_{\Phi=1}) \geqslant e(x_{\Phi=1})$. If this is no longer the case, the agent will choose not to engage in the activity at all. Activity choices under these types of preferences are depicted in Figure 4.5 in the Appendix.

4.3 Experimental design

I conducted a computer-based experiment to measure how compliance efforts change when the degree of legal standard vagueness is varied and when the compliance choice imposes a negative externality on a second participant. Participants were asked to make 12 compliance choices under each of 6 different degrees of standard vagueness, both in conditions with and without imposing negative externality on another participant.

I refer to the the first six choices as the 'baseline' choices. In the six baseline choices the participants reproduce the choice as in Chapter 3. They decide on an activity level, while payoff as well as the probability and magnitude of a repayment increase in the activity level. The choices only affect the decision makers expected payoff and do not generate an externality for another participant. Potential repayments are made to the experimenter.

I refer to the second set of choices as 'treatment' choices. In the six treatment choices, the participants choose an activity level which also affects the payoff of another participant in the laboratory. The magnitude of the participant's own payoff and the size of the negative externality on another participant increase with the activity level. Simultaneously, the probability and magnitude of the repayment also increase in the activity level. Repayment in this case is made to the player who was exposed to the externality and fully compensates the loss from the externality. In this choice situation the decision maker needs to trade off his own payoff against the payoff of another participant.

In each of the 12 conditions, participants used a slider to choose an activity level between 0 and 1000 units. If their chosen activity level was at or below the subsequently determined maximum level, the participant earned a full payoff. If the chosen activity level was higher than the maximum level, the participant had to repay part of the payoff. Depending on the treatment, either to the experimenter or to the second player who had been affected by the negative externality from the activity. The degree of vagueness in the legal standard determined the probability of a repayment at every chosen activity level. Choosing an activity level therefore resembled a choice between 1001 lotteries with different payoffs and probabilities.

The experiment was programmed using z-Tree (Fischbacher, 2007). I conducted 5 sessions with a total of 78 participants in December 2015 at the economic laboratory of the Friedrich Schiller University in Jena. Two participants had to be excluded, leaving a total of 76 observations.[7] The participants were students recruited through Orsee (Greiner, 2004). All decisions were incentivised, with average earnings amounting to about €9, including the mandatory show-up fee of €2,50. Each session lasted approximately 45 minutes. The participants received instructions via video clips which explained the functionality of the computer interface, illustrated earning opportunities and which provided an effective visual aid in explaining the construction and consequence of the vague behavioural standard.[8]

4.3.1 Task

In the first stage of the main game the participants selected their preferred activity level on a slider ranging from 0 to 1000 units. The higher the chosen activity level, the higher was the potential payoff in each of the 12 conditions. The interface provided graphical representations of the potential payoff, the potential repayment and the likelihood of meeting the behavioural standard. Payoffs were reported in Experimental Currency Units (ECU), where 1 ECU was equal to €0,04. Specifically, payoffs for the slider choice were:

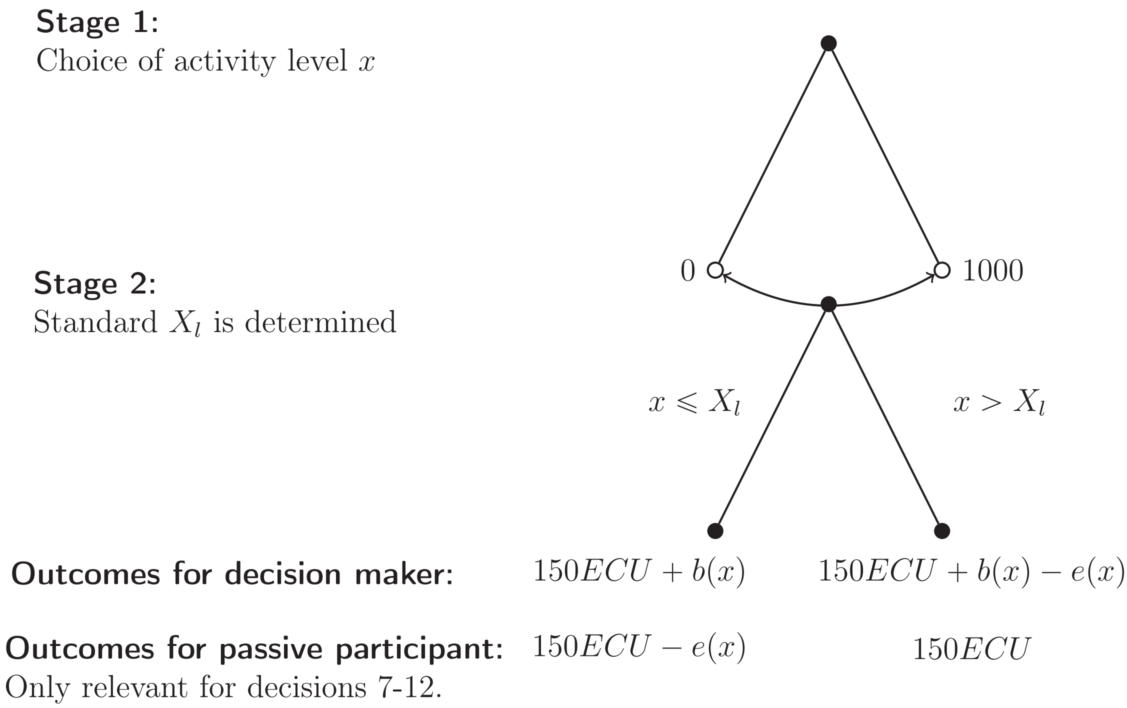
$$\Pi(x) = \begin{cases} b(x) = 50\ \ln(x) & \text{if } x \leqslant X_l \text{ (compliance)} \\ b(x) - e(x) = 50\ \ln(x) - 0.1x & \text{if } x > X_l \text{ (violation)} \end{cases}.$$

In the second stage of the main game the liability standard X_l was drawn from a normal distribution, with a mean of 500 and a standard deviation which reflected the relevant degree of legal uncertainty. The six different levels of standard vagueness were represented by standard deviations of $\sigma_i \in \{1, 100, 200, 300, 400, 500\}$.

It was then determined whether the chosen activity level was compliant with the drawn liability standard X_l. If the activity level was smaller or equal to the liability standard, the participant received the full payoff $b(x)$. If the activity level exceeded the standard, the participant received $b(x)$ less the repayment $e(x)$. The structure of the main game is illustrated in Figure 4.2.

[7] The original data set includes 78 participants. One participant with prior knowledge of the main game and one participant who failed to answer the comprehension questions were

Figure 4.2 Game representation of the main task



Each participant took decisions under 6 different degrees of standard vagueness in the presence and absence of an affected second player, a total of 12 decisions per participant.[9] All twelve decisions were made in one stage and within the same screen. The computer screen featured icons for all 12 decisions and participants could choose the order in which they attended to the scenarios by clicking on the icons. They could also edit previous decisions. This set-up was chosen to prevent effects related to the sequence in which the scenarios were presented, and to allow participants to compare scenarios and previous decisions. Refer to the Appendix for a sample decision screen from the experiment (Figure 4.6).

eliminated from the data set, prior to the analysis.

[8] https://www.dropbox.com/sh/lyffejt05mr110q/AABZu2ktuqfzXCfX6z5XwBKra?dl=0

[9] The six specific choice situations are derived from Calfee and Craswell's (1986) Table 1, using the same parameterisation as in Chapter 3.

For the six decision scenarios in which another player was affected, all participants were separated into 'active' and 'passive' participants, but not initially informed about their role. All participants selected an activity level which imposed a negative externality on a passive player. Subsequently the decision was implemented in accordance with the assigned role. The participants received an initial endowment of 150 ECU before the first stage to prevent a negative payoff for passive types.

After the main task, I conducted two post-tests to reveal participants' social- and risk preferences. I elicited risk preferences following a multiple price list approach according to Holt and Laury (2002) and elicited social preferences according to the ring measure as devised by Murphy, Ackermann, and Handgraaf (2011) and implemented for z-Tree by Crosetto, Weisel, and Winter (2012).

4.3.2 Experimental hypotheses

Before analysing the effect of social considerations, I establish whether my baseline data replicates the results from Chapter 3. Therefore, I am interested in effect of standard vagueness on selected activity levels in the baseline section of the experiment. As in Chapter 3, I want to determine whether the data displays convexity, with decreasing activity levels up to a turning point, after which activity levels increase as predicted by Calfee and Craswell (1986). Therefore Hypothesis 1 is concerned with the shape of the relationship:

> **Hypothesis 1 (Convexity):** The choice behaviour in the baseline condition displays convexity. Chosen activity levels decline at a decreasing rate in standard vagueness. Beyond a minimal turning point, chosen activity levels increase in standard vagueness.

After establishing the baseline case, Hypothesis 2 is concerned with the presence of a treatment effect when the activity imposes an externality on another participant. Specifically, I determine whether the chosen activity levels from the baseline section lie below the activity levels from the treatment section of the experiment, as predicted in Section 4.2.

Hypothesis 2 (treatment effect): At all tested levels of standard deviation, activity levels in the baseline condition lie below the chosen activity levels in the treatment condition.

Hypothesis 3 is concerned with the domain of the divergence between baseline and treatment section. The vast majority of the models in Section 4.2 predict not only higher average activity levels in the treatment section, compared to the overcompliance in the baseline section, but also that they will lie above the socially efficient level in the domain of undercompliance.

Hypothesis 3 (undercompliance): At all tested levels of standard deviation in the treatment condition, participants will choose activity levels in the undercompliance domain.

In Hypothesis 4 I focus on the effect of social value orientation (SVO) on the shape of the response function. Social value orientation is measured in an incentivized post-test, recorded as a continuous measure. This allows to compare participants in terms of their relative preference for individualistic, prosocial or altruistic decisions. In line with the predictions in Section 4.2, I hypothesize that these measures affect the overall level of choice behaviour and affect the shape of the response function, with higher values of the inequality aversion score/angle leading to 'decreased' concavity in the response function in the treatment section of the data.

Hypothesis 4 (social value orientation): Social value orientation affects activity choice, both in terms of the level of behaviour and in terms of the shape of the response function. The linear effect is (more) positive, while the shape is 'more concave'.

In Hypothesis 5 I will shed light on the development of the variability of decisions. In Chapter 3, we referred to the increasing variability of chosen activity levels at higher levels of legal standard vagueness as 'erratic behaviour'. This pattern embodies a considerable social cost of standard vagueness, namely the loss in coordination, brought about by (relatively) certain legal standards.

I want to test whether the degree of this costly loss of coordination persists in the treatment section.

> **Hypothesis 5 (variability):** The variability of chosen activity levels increases with the level of standard vagueness in baseline and treatment group.

4.4 Analysis & Results

I present the results in two subsections. Initially I provide descriptive statistics and highlight the differences and similarities to the results from Chapter 3. Secondly, I will conduct a detailed evaluation of the experimental hypotheses set out in Subsection 4.3.2.

4.4.1 Descriptive statistics and relation to the previous experiment

The sample consists of 76 students from various academic backgrounds. The average age was about 25 years, and approximately 57% of the sample were female.

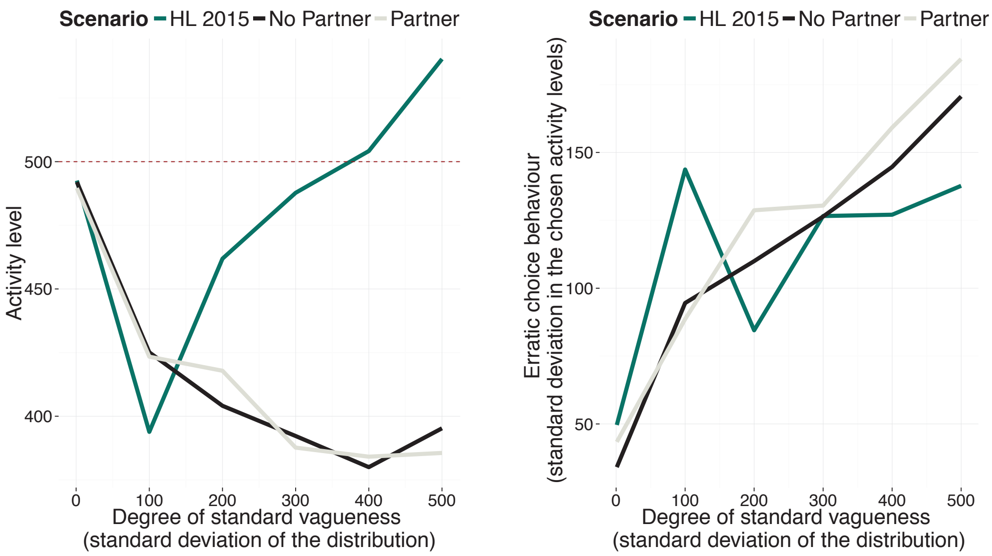
To better grasp the level of comprehension in the main game, all participants were asked to report on their knowledge of mathematics and their perceived understanding of the main task within a questionnaire at the end of the experiment. Roughly 79% of the participants reported being comfortable with handling fractions and calculating percentages, which is crucial to completing the choice task. Despite the presence of participants with relatively low self-reported math skills, about 96% of the participants stated that they fully understood the task. I conclude that the participants made their decisions deliberately and in full awareness of the consequences. The results of the questionnaire are summarised in Table 4.3 in the Appendix.

Figure 4.3 depicts the average activity choices from the main game and compares the data to the results from Chapter 3. The left panel shows the mean activity level, for each level of standard vagueness. The green line shows the U-shaped response curve, as found in Chapter 3. The equivalent data from the baseline section of the recent study is depicted by the black line, and decisions with an externality-affected second party are depicted by the grey line.

Neither the data from the baseline section, nor the data from the treatment section seem to replicate the findings from Chapter 3, but seem to be indicative of convexity, as per Hypothesis 1. Furthermore, activity levels in the treatment section do not appear to be significantly higher than in the baseline section (Hypothesis 2) and average activity levels in both data sections lie in the overcompliance domain (Hypothesis 3).

The right panel of Figure 4.3 displays the standard deviation of the choices at each activity level, which is used to measure the degree of volatility and unpredictability in behaviour. The data seems to reinforce Chapter 3's finding that behaviour becomes more erratic as legal standard vagueness increases (Hypothesis 5).

Figure 4.3 Mean and standard deviation of activity choices at each vagueness level



4.4.2 Testing the hypotheses

Hypothesis I: Convexity in the baseline results

In Hypothesis 1 (Convexity), I suppose that average activity levels in the baseline section of the experiment follow a convex distribution. This supposes that activity choices initially decrease with standard vagueness, but at a slowing rate. Beyond a minimal turning point activity choices might then even commence to increase in standard vagueness, resulting in the characteristic U-shape, detected earlier in Chapter 3. While Figure 4.3 in the previous section does not display a U-shape for the baseline data, it does show slight convexity.

To test for the presence of convexity, I estimate the chosen activity level in the baseline section of the data as a function of standard vagueness (SD) and squared standard vagueness. The coefficient of squared standard vagueness in Table 4.1 is positive and significant, pointing to slight convexity, providing evidence in favor of Hypothesis 1. While the overall trend is negative, this might only hold for the given range of vagueness levels. It is not unlikely that we would observe a positive slope at very high levels of standard vagueness, completing the U-shape. It is worth noticing that risk preferences have a significant effect on choice behaviour. The higher the degree of risk aversion, the lower the selected activity level.[10]

Overall, I do find evidence in support of Hypothesis 1 and can conclude that activity choices follow a convex pattern in the baseline part of the experiment.

A more detailed analysis reveals heterogeneity in the individual response patterns. Figure 4.8 in the Appendix graphically represents this heterogeneity. I estimate the individual coefficients for standard vagueness and squared standard vagueness and plot these against each other. The plot reveals convexity ($\beta_{SD^2} > 0$) for the majority of observations and U-shaped response patterns ($\beta_{SD^2} > 0$ and $\beta_{SD} \approx 0$) for approximately 29% of the participants. Individual response patterns are also displayed in Figure 4.7 in the Appendix.

[10] For a complete analysis, the equivalent results for the treatment data are printed in Table in the Appendix. As suggested by Figure 4.3 the findings do not differ much between baseline and treatment section. The coefficient of squared standard vagueness is slightly smaller than in the baseline section, showing less convexity. This small difference can be found in Figure 4.3 as well: average activity choice levels are higher in the baseline data than in the treatment data at vagueness levels of SD300 and SD500, and lower at SD400.

Table 4.1: Effect of standard vagueness and squared standard vagueness on the activity choice in the baseline data

	Activity choice Model 1 (OLS)	Activity choice Model 2 (OLS)
SD	-0.6762^{***}	-0.5032^{***}
	(0.0766)	(0.1106)
SD^2	0.0009^{***}	0.0007^{***}
	(0.0002)	(0.0002)
Risk Preferences		-3.4687^{**}
		(1.6052)
(Intercept)	500	500
	(set within the model)	(set within the model)

*: $p < 0.10$; **:$p < 0.05$; ***:$p < 0.01$

Result 1 (Convexity): I find convexity in the baseline data, but cannot replicate the U-shaped reaction to standard vagueness, as found in Chapter 3.

Hypothesis 2: The treatment effect

In Hypothesis 2 (treatment effect), I test for a difference in the chosen activity level between baseline section and treatment section. Specifically, I am interested whether the participants choose on average lower activity levels in the baseline section of the data (without a second player), than in the treatment section of the data (affected second player).

For the overall comparison of activity level choices in the baseline and treatment section of the experiment, I regress the level of standard vagueness and squared standard vagueness on the activity level and interact them with a dummy variable, which takes the value 0 in the baseline section and the value 1 in the treatment section. In line with the model I predict a positive effect of SD in the treatment section and a negative coefficient for squared vagueness, indicative of concavity. While these coefficients hint at the hypothesized direction of the treatment effect, the difference is small and not significant. Therefore I cannot conclude that activity levels differ between baseline and treatment section and do not find evidence in support of Hypothesis 2. The results are displayed in Table 4.2.

Result 2 (treatment effect): Choices do not differ between baseline and treatment section. The generation of a negative externality for another participant does not affect chosen activity levels.

Table 4.2: Effect of standard vagueness and squared standard vagueness on the activity choice by treatment and social preference

	Activity choice (by treatment) Model 3 (OLS)	Activity choice (SVO) Model 4 (OLS)
SD	−0.6762***	−0.8283***
	(0.0796)	(0.1559)
SD^2	0.0009***	0.0012***
	(0.0002)	(0.0004)
treatment	−16.5744	
	(13.169)	
SD:treatment	0.1736	
	(0.1473)	
SD2:treatment	−0.0003	
	(0.0003)	
SVO angle		−0.4224
		(0.5975)
SD: SVO angle		0.0137*
		(0.0081)
SD2: SVO angle		−0.000024
		(0.000017)
(Intercept)	500	500
	(set within the model)	(set within the model)

*: $p < 0.10$; **:$p < 0.05$; ***:$p < 0.01$

Hypothesis 3: Undercompliance in the treatment section

Hypotheses 1 and 2 are concerned with the effect of vagueness increases and the introduction of an affected participant on the activity level. They are not concerned with the question whether the activity takes place in the domain of overcompliance, undercompliance or at social efficiency. In line with the predictions from the theory chapter, Hypothesis 3 (undercompliance) states that activity choices will be undercompliant at all levels of standard deviation in the treatment condition. Graphically, the left panel in Figure 4.3 in the previous section already illustrates that all activity choices in baseline and treatment section lie in the domain of overcompliance (below 500). This intuition is confirmed in the results in Table 4.4 in the Appendix. I regress standard vagueness and squared standard vagueness on the choice variable in the treatment section, while setting the intercept at the point of strict compliance (500). The results show that increases in standard vagueness reduce the chosen activity level below strict compliance, actually into the domain of overcompliance. The choice pattern exhibits convexity.

Hence, I do not find evidence in support of Hypothesis 3.

> **Result 3 (undercompliance):** In baseline and treatment group, icreases in standard vagueness lead to similar levels of overcompliance.

Hypothesis 4: The effect of social preferences on the shape of the response function

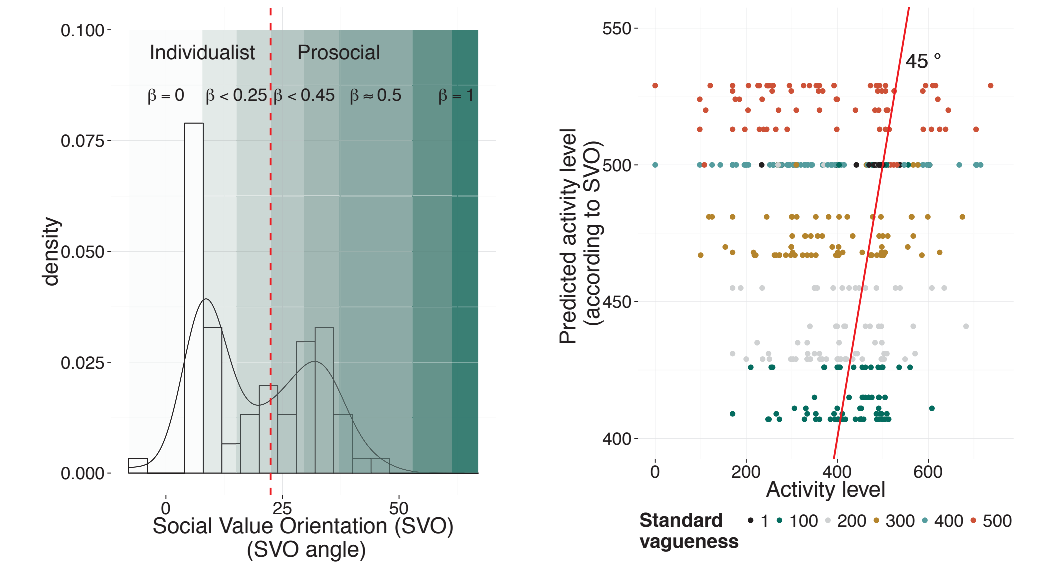
In Hypothesis 4, I look at the effect of the separately measured indicators of social preference on the shape and location of the response function. I conducted the slider task by Murphy, Ackermann, and Handgraaf (2011) in order to gain a standardized measure for social preferences in the sample. The observations lie between values of -7.565 and 45, indicating a range of preferences from perfectly individualistic to prosocial/ efficient. The distribution is depicted in the left panel of Figure 4.4. In order to relate the findings to the model in this chapter, I have associated the angle measure from the post test with categories of β-values, in accordance with the information provided by Murphy, Ackermann, and Handgraaf (2011). Perfectly individualistic preferences are associated with $\beta = 0$, preferences for social efficiency with $\beta = 0.5$ and maximin preferences correspond to $\beta = 1$.

In all evaluated theoretical models the type of social preference is predicted to alter the shape of the response curve. Specifically, it is predicted that individualistic preferences are associated with convexity and relatively lower activity choices on average. Prosocial preferences are associated with concave response curves and relatively higher chosen activity levels. Model 4 in Table 4.2 displays the results from regressing the standard vagueness, squared standard vagueness, the angle measure for social preferences (SVO angle), as well as their interaction on the activity choice in the treatment section of the data. Standard vagueness as well as the squared term remain significant, with coefficients similar to those of previous models. Social preferences alone do not seem to have a significant effect, but the interaction with standard vagueness is significant at the 10-percent level. The data indicates a less negative effect of standard vagueness for participants with 'more prosocial' preferences. This finding is in line with the prediction of Hypothesis 4. Yet, I do not find social preferences to alter the degree of convexity of the response function. While the coefficient of the interaction between the social preference measure and squared standard vagueness has the expected sign and magnitude, it is not significant. As I find social preferences to affect the level of the choice variable, but not it's shape, I cannot fully accept Hypothesis 4.

> **Result 4 (social value orientation):** Participants whose preferences are 'more prosocial' decrease activity levels relatively less in response to increases in standard vagueness. Defensive Behavior seems somewhat mitigated by social preferences.

Since social preferences affect activity choices, I proceed to inquire whether stated social preference can predict the actual activity choice in the main part of the experiment. The right panel of Figure 4.4 delivers an insight into the predictive power. I generate predictions for the activity choice by plugging the individual β-values into the theoretical model. The results are plotted against the actual activity choice. Choices in which the social preference is consistent across the two tasks are found in close proximity to the 45°-line. Firstly, it can be seen that the majority of predictions based on the stated social preference are too high, indicating that social preferences are inconsistent across different tasks. Secondly, the accuracy of predictions based on social preferences decreases with standard vagueness. The latter finding could indicate that higher standard vagueness is also perceived as a lack of behavioural guidance by the law maker and reduces the perceived importance of fairness and prosocial conduct of the individuals.

Figure 4.4 Measured social value orientation and its impact on activity choice



Result 4b (social value orientation): The accuracy of choice predictions, based on social preferences declines as standard vagueness increases. Predictions of activity choices, based on the observed social preferences are on average too high.

Hypothesis 5: Increasingly erratic behaviour

In Hypothesis 5, I suggest that the variability of chosen activity levels increases as standard vagueness grows larger. This translates into increasingly erratic behaviour, an infrequently discussed byproduct of vague standards. As behaviour becomes more difficult to predict, the law looses its coordination function. In practice the legal standard serves as a measure to coordinate precaution. It indicates to a potentially injured party whether a possible tortfeasor will take precaution or whether it is best to purchase insurance. As behavior becomes increasingly erratic, this function of the standard is lost.

I define the variability in terms of the standard deviation of chosen activity levels, for each degree of standard vagueness. By means of a Jonckheere-Terpstra test, I reject that variability is constant over changes in standard vagueness, against the alternative, that it increases. Aside from the cost through overcompliance, as established in Hypothesis 3, we can therefore associate high levels of standard vagueness with a cost from the uncertainty for potential injured parties, as these adapt their behaviour, become cautious or invest in insurance to brace for injury without restitution.

The results listed in Table 4.5 in the Appendix confirm the conjecture drawn from the right panel of Figure 4.3 in the data description. I therefore find strong support for Hypothesis 5.

> **Result 5 (variability):** As standard vagueness increases, choice behaviour becomes increasingly erratic.

4.5 Discussion

In this chapter I investigate the effect of legal standard vagueness on the investment in compliance with the standard. It therefore fits into the law and economics literature on compliance and deterrence. In the experimental literature, it complements the vast body of literature on deterrence under uncertain or risky punishment conditions, but focuses on a scenario outside of criminal law. Here, the policy maker doesn't want to minimize a certain type of behaviour, but rather to induce efficient behaviour.

Aside from re-testing the findings from Chapter 3, namely a U-shaped relationship between the investment in precaution and the degree of standard vagueness, this experiment investigates the interplay of vague standards with social preferences where a participant's actions impose an externality on a second participant.

While I do find convexity in the response function to the vague standard, I cannot replicate the U-shaped response function, moving from overcompliance to undercompliance, which had been reported in the previous chapter. Instead, the activity choice decreases over the entire tested range of standard vagueness. Still, a more detailed analysis reveals that slightly less than a third of the participants make choices according to a U-shaped relationship.

The data also fails to present a treatment effect. Even after controlling for different degrees of social preferences, participants make similar choices in the baseline and the treatment section of the experiment.

A possible explanation for the flatter U-shape, the lack of a treatment effect and even the unexpected overcompliance in the treatment section might be that the expression of social preferences generally differs across situations. A possible explanation for this can be found in theories of social psychology. Cognitive dissonance aversion (Festinger, 1957; Aronson, 1969; Konow, 2000) predicts that individuals prefer to reduce the "dissonance" or psychological inconsistency of their motivations and choices by altering their behaviour.[11] On the one hand, it is possible that a participant who has made one or more overcompliant decisions will be more inclined to make similar decisions at other vagueness levels. On the other hand, this theory might explain the small treatment effect. The participant may experience cognitive dissonance between her self-interest for increasing her own payoff and fairness towards the affected second player. To reduce this unpleasant conflict, without reducing self-interested behaviour, the participant may engage in self-deception. The participant can do so by telling herself that the moral responsibility towards the second player is outsourced to the authority who sets and enforces the behavioural standard.

A further potential explanation for the results may be the design of the choice architecture, which may have induced status-quo bias. Although the participants could freely choose the order in which they edited the scenarios, with and without an affected second player, most participants initially attended to the choice scenarios which did not involve a second player. By having already chosen an activity level for each level of standard vagueness in the baseline section, the participants may have provided their own anchor for the equivalent decision in the treatment section, where a second player is involved. Experimental evidence documents the existence of anchoring in sequential decisions and also suggests that status-quo bias is particularly strong for large choice sets (Samuelson and Zeckhauser, 1988), such as the one in present experiment. A similar argument can explain the monotonic decrease in the choice variable when vagueness increases. The gradual change of the

[11] Of particular interest here is the literature on the experienced dissonance following a decision- making process. Early experimental evidence has been provided by Brehm (1956), who finds that individuals who were asked to reevaluate a difficult decision tend to reinforce their preference for the chosen option. The author asked individuals to rate two appliances and then choose between them. When the individuals were asked to rate them again, the individuals emphasised the positive attributes of their chosen option and attenuated the negative aspects.

vague standard might be responsible for preventing participants from detecting the level at with a change in behaviour might be beneficial. A popular metaphor for behaviour of this type is that a frog can be boiled if he is put into a pot with cold water and the temperature is increased just slowly enough. Yet, if the frog was placed into a pot of boiling water, he would jump right out. As a suggestion for further research, the study might be replicated on a between subjects basis; that is, subjects choosing activity levels at differing levels of standard vagueness for either the second player scenarios or the non-second player scenarios.

While I find an effect of social preferences on the activity choice and find that pro-social preferences somewhat mitigate defensive behavior, the results from the post test only weakly predict actual activity choices. On average, the employed data from the post test delivered predictions that were too high, suggesting that subjects were on average more prosocial in the post test, than in the main game. This might have to do with the relatively higher degree of complexity in the main task of the experiment. As a consequence, participants may have been preoccupied with the assessment of their own profit and potential liability, rather than the impact on another participant. This would also be in line with the finding that the precision of the prediction based on social preferences decreases with increases in standard vagueness.

Alternatively, it is also possible that the law maker is perceived as the moral authority in the experiment. As such, he assumes responsibility for the employment of fair standards and crowds out individual social preferences or fear of social diapproval[12] Moreover, increasingly vague standards can be perceived as unfair and break down fair and pro-social conduct in the laboratory.

Finally, I confirm the intuition from Chapter 3 regarding the existence of a further hidden cost to standard vagueness. When the behaviour of one party becomes increasingly erratic, it becomes very difficult for society to anticipate. The consequence may be an excessive investment in insurance by the potential bearer of an externality or by a state entity.

[12] This can be related to the field study by Gneezy and Rustichini (2000) who find that the intruction of a fee system for parents who pick their children up late from kindergarden has adverse effects. The regulation of the situation has parents crowd out their social preferences towards the teachers.

4.6 Conclusion

The experimental results presented in this chapter offer a contrasting view to Calfee and Craswell's (1986) results, as well as to the experimental evidence in Chapter 3. In fact, the results offer empirical support to the argument of traditional legal scholars, who claim that the increase of legal uncertainty leads to the erosion of socially beneficial activity levels. The data doesn't hint at the presence of a desirable alternative to legal certainty and provides two arguments for the systematic reduction of legal standard vagueness: On the one hand, inefficiency (in terms of overcompliance) increases with standard vagueness, and on the other hand choice behaviour becomes more erratic and less predictable. The latter expense is discussed less frequently, but can be very high. Passive parties, potential bearers of the externality, who seek to shield themselves from costly externalities are induced to invest in precaution by purchasing insurance or opting out of socially beneficial activities completely.

While we find that pro-social preferences somewhat mitigate defensive behavior, it looks as if individuals do not distinguish between situations in which they saliently harm another individual and those in which they don't. This can serve as an explanation for the prevalence of defensive behaviour in principal-agent relationships in which agents forego the best action, out of fear of liability. Instead, individual social concerns seem to lose priority when individuals are confronted with a vague standard. This result indicates that lawmakers cannot rely on the intrinsic motivation which generates socially desirable outcomes in a variety of other scenarios. Whether this is due to dealing with increasingly complex situations or to an adverse signalling effect is unclear. Despite the divergence from previous results, this study further highlights the sensitivity to legal standard vagueness and should raise awareness amongst law- and policy makers. It should also provide the motivation to investigate the perception of, and the reaction to standard vagueness in the field and in more clearly defined legal situations, such as medical malpractice or tax compliance. This might offer further insight into the reaction to vague standards in different contexts of social proximity and might have the potential to reduce society's cost of defensive behaviour.

4.7 Appendix

Figure 4.5 Over- and undercompliance including Rawlsian Preferences

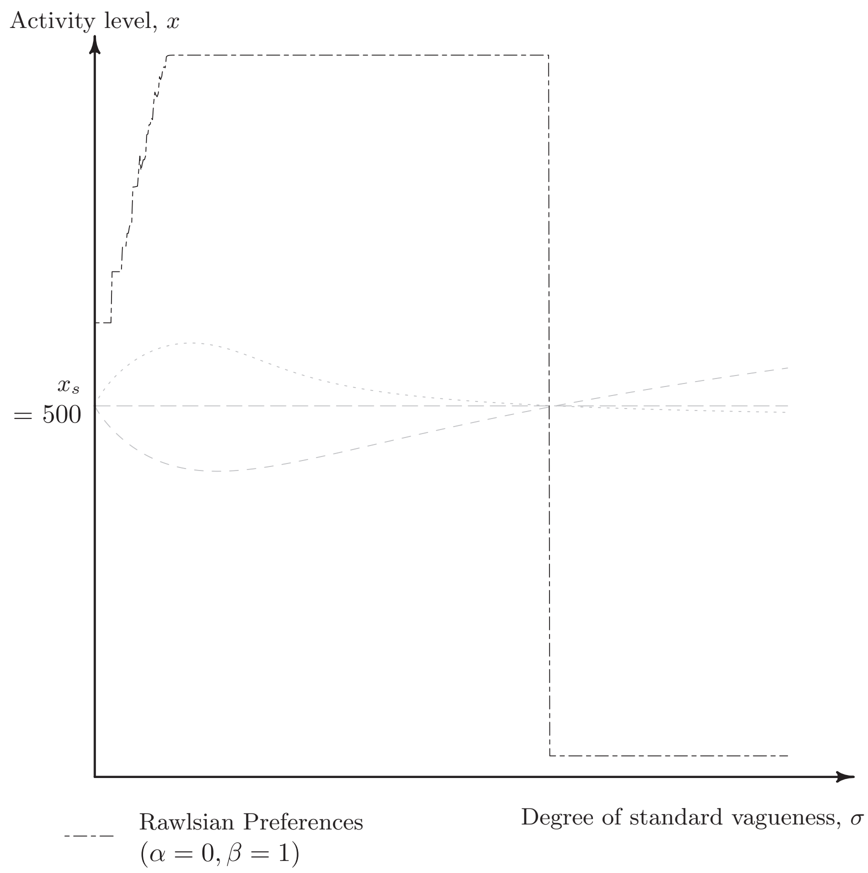


Figure 4.6 Sample Screen of the Decision Screen in the Experiment

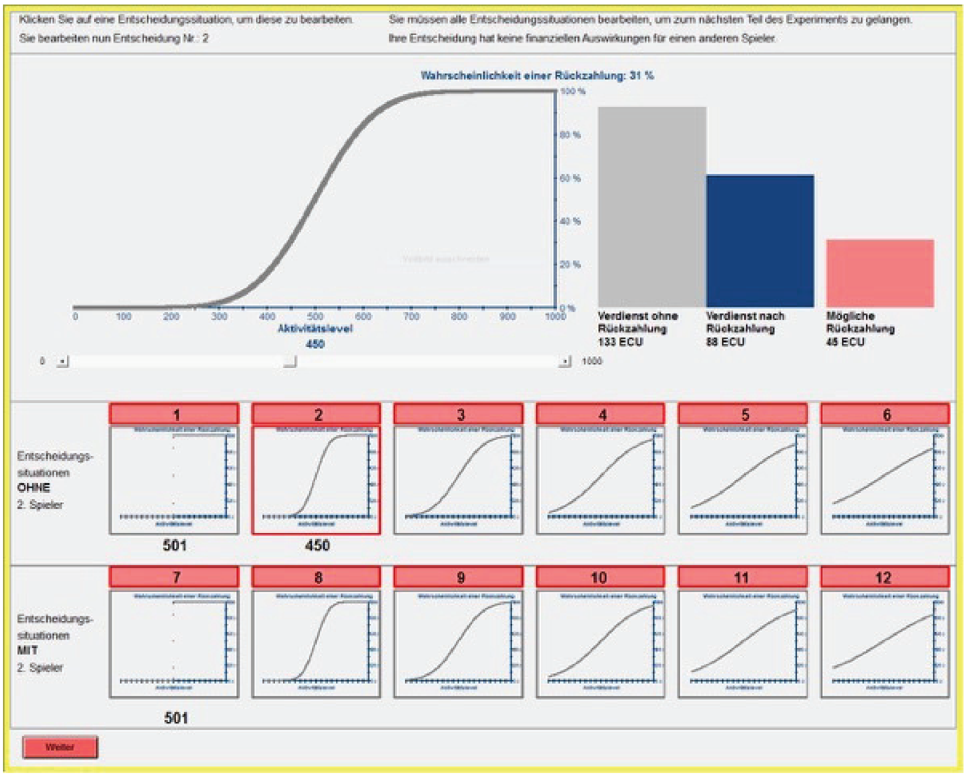


Table 4.3: Results from the questionnaire

Self-reported math level	1	2	3	4	5
"What level of math do you still feel comfortable with?"	basic arithmetic (written)	basic arithmetic mental)	percent & fractions (written)	percent & fractions (mental)	optimization problems (written)
	6.6%	14.5%	32.9%	23.7%	22.4%
Understanding	1	2	3	4	5
"Do you feel that you understood the task in the main game?"	"I am not sure I understood the task correctly."	"I did not understand the task description."	"Only partially."	"Yes, but it wasn't easy."	"Yes, it was easy."
	1.3%	0.0%	2.6%	35.5%	60.5%

Table 4.4: Effect of standard vagueness and squared standard vagueness on the activity choice in the treatment data

	Activity choice Model 1 (OLS)	Activity choice Model 2 (OLS)
SD	-0.622***	-0.4131***
	(0.0827)	(0.1192)
SD^2	0.0008***	0.0005**
	(0.0002)	(0.0002)
Risk Preferences		-4.189*
		(1.7312)
(Intercept)	500	500
	(set within the model)	(set within the model)

*: $p < 0.10$; **:$p < 0.05$; ***:$p < 0.01$

Table 4.5: Jonckheere-Terpstra test on changes in variablity

Subset	Alternative Hypothesis	Test statistic (JT)	P-value
Overall	Increasing	59	0.001
Baseline	Increasing	15	0.003
Treatment	Increasing	15	0.003

Figure 4.7 Individual choices in the baseline condition

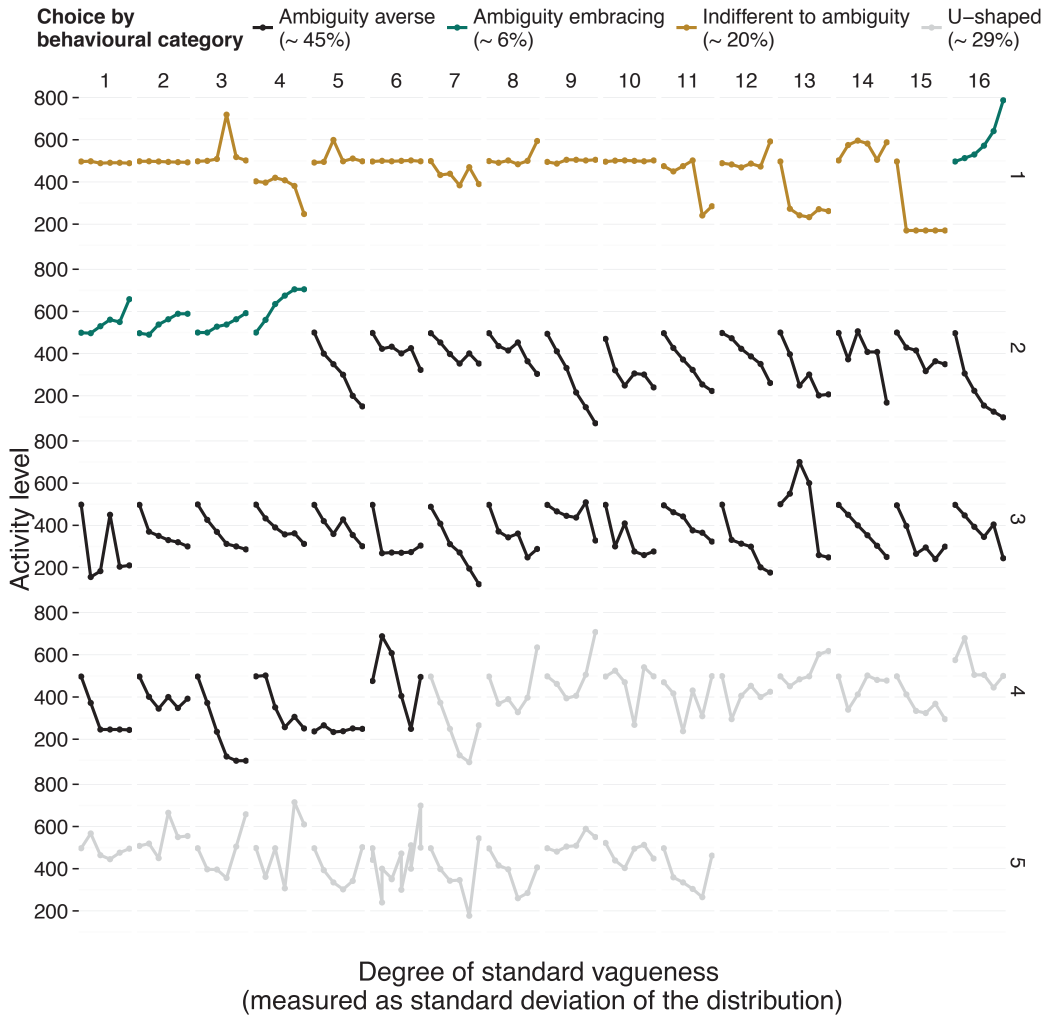
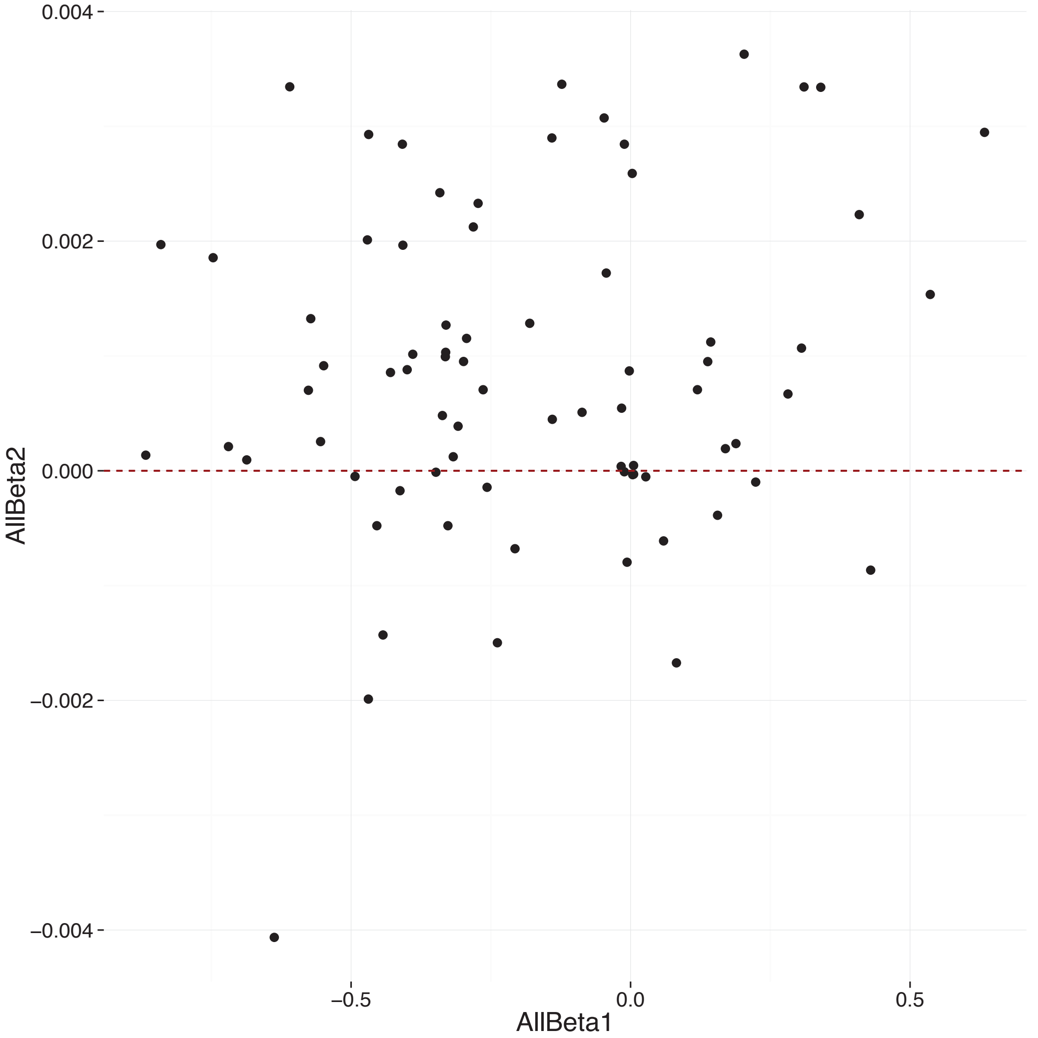


Figure 4.8 Individual choices in the baseline condition, classified by their coefficients



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Erklärung nach §4, Abs.2 PromO

Hiermit erkläre ich,
1. dass mir die geltende Promotionsordnung bekannt ist;
2. dass ich die Dissertation selbst angefertigt, keine Textabschnitte eines Dritten oder eigener Prüfungsarbeiten ohne Kennzeichnung übernommen und alle von mir benutzten Hilfsmittel, persönlichen Mitteilungen und Quellen in meiner Arbeit angegeben habe;
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Jena, den 26.07.2016

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Experience

enercast GmbH — **Kassel, Germany**
Student Employee, Researcher — *2012–Present*
I developed advertising and presentation materials, conducted market research & market analyses.

Annalise — **Utrecht, The Netherlands**
Student Researcher — *2008–2010*
I conducted market analyses for a variety of products & managed client correspondence.

Lurgi AG — **Frankfurt, Germany**
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I supported the IT- and & Communications departments in the preparation of a DMS roll-out.

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I created and presented materials concerning best practice in IT.

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Awards & Scholarships

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